

EFFECTS OF SEX AND MASS DENSITY ON THE MECHANICAL PROPERTIES OF THE HUMAN PATELLAR TENDON

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INTRODUCTION

A diverse range of values for the mechanical properties of the human patellar tendon has been reported in the literature. These discrepancies persist even though similar test environments and specimen cross-sectional areas are used [1,2,3]. Since patellar tendon is used as an autogenous graft for ACL reconstruction, it is important from a clinical point of view to know the reasons for the variations in the reported properties. Donor age has been excluded as a factor that causes this disparity; at least in the age range below 50 years [2,3]. Since sex and collagen content are known to affect mechanical properties of some connective tissues [4,5], it is reasonable to believe these factors might be causing variability in the properties of patellar tendon. In this study, we hypothesize that 1) female patellar tendons have inherently inferior mechanical properties as compared to male patellar tendons and 2) the mechanical properties of the patellar tendon are correlated to its mass density.

METHODS

Twenty patellar tendons were harvested along with their bony attachments from unpaired knees (10 male and 10 female). The mean age of male donors was 39 years (range 26-50) and that of female donors was 37.7 years (range 17-50). The central portion of patellar tendon (average width of about 5mm) was trimmed. Its length, average width and thickness were measured using a caliper. The patellar tendon was tested to failure at a strain rate of 100%/s in a tensile testing apparatus. After the test, the tendons were carefully removed from their attachment sites and weighed accurately. The mass density of patellar tendon was calculated. The PT was kept moist by 0.1N saline solution throughout the experiment. Statistical tests were performed to compare mechanical properties of male and female patellar tendons. Correlation analysis was performed to test the correlation between the mass density of the tendon and mechanical properties.

RESULTS AND DISCUSSION

As shown in Table 1, no evidence of a sex-based difference in mechanical properties of human patellar tendon was found. The results revealed a diverse range of mass densities extending from a low of 0.76 g/cm³ to a high of 2.68 g/cm³ (250% difference) and the same was true with mechanical properties. The ultimate strength (Figure 1), elastic modulus

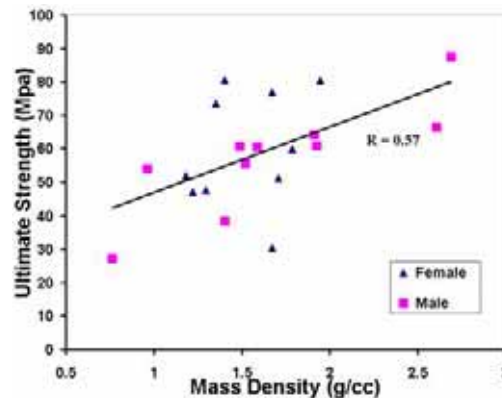


Figure 1. Correlation between mass density and ultimate strength

and toughness of patellar tendons were found to be correlated to the mass density. The tensile strength and elastic modulus were significantly higher for those patellar tendons having a mass density greater than 1.67 g/cm³. Sex does not seem to affect the mechanical properties of patellar tendon and hence the effect of sex might be tissue specific. The ranges in mass density and mechanical properties highlight the need for considering the quality of autograft before ACL reconstruction. Based on our findings, it is evident that mass density can be used as a predictor of mechanical properties of human patellar tendon. The need for such predictors is highlighted by some researchers [6]. Modern imaging techniques such as CT scans can be used to find the mass density of the patellar tendon to assess its suitability for use as a graft. Higher mass density might reflect higher amount of collagen and hence reflect better tissue quality [5]. Biochemical and histological studies are needed to verify our results.

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Table 1: Mechanical properties of male and female patellar tendons and P-values based on t-test.

	Ultimate strength - MPa	Failure strain	Elastic modulus MPa	Toughness MPa
Male	57.5 ± 15.2	0.18 ± 0.03	501.4 ± 143.6	4.37 ± 1.1
Female	59.9 ± 17.2	0.18 ± 0.04	513.4 ± 134.1	4.82 ± 0.8
P-value	0.63	0.61	0.57	0.84