MECHANICAL PROPERTIES OF HUMAN FLEXOR HALLUCIS LONGUS, PERONEUS BREVIS AND TENDO ACHILLES TENDONS

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INTRODUCTION
Repair of neglected Achilles tendon rupture is often complicated due to tendon retraction, atrophy and a small distal stump. Review of the literature suggests excellent results after repairs of neglected tears of Achilles tendons with the use of both the flexor hallucis longus (FHL) [1], the peroneus brevis (PB) [2-5] or gracilis[6]. Synthetic materials such as a dacron graft [7] or Marlex mesh [8] have also been reported. Despite the clinical success of both the tendon transfers as reported extensively, there is little data which reports the mechanical properties of the FHL and PB tendons which supports the use of a particular tendon transfer for a better repair. The mechanical properties of the FHL and PB have not been well reported. The strength and stiffness of the graft may play an important role in the clinical outcome of these repairs. This study examined the tensile properties of the FHL, PB and Tendo Achilles (TA) tendons harvested from fresh frozen human cadavers.

METHODS
The FHL, PB and TA tendons were harvested from 17 fresh frozen human cadavers free of any gross pathology (mean age 69 years old). Samples were stored in frozen in phosphate buffered saline prior to testing. Mechanical testing in uniaxial tension at 100 % per minute was performed using an MTS Bionix testing machine. Samples were secured using a special jig for the bony aspect and by freezing the tendons in “cryogrips” using liquid carbon dioxide. The peak load (N), linear stiffness (N/mm) and energy to peak load (N*mm) were determined for the load versus displacement data using Matlab. Mechanical data was analysed using a 1 way analysis of variance (ANOVA) followed by a Games Howell multiple comparison post-hoc test.

RESULTS
A total of 51 tendons were harvested from the 17 cadaveric specimens. Mechanical testing was successfully completed in all samples apart from 1 PB that slipped from the grips during testing. This sample was omitted from further analysis. The mean ultimate loads differed for each group with the TA tendons being the strongest (1724.5 N ± 514.3) followed by FHL (511.0 N ± 164.3) and PB (333.1 N ± 137.2) (P<0.05) (Figure 1). Similar results were found with respect to energy with TA tendons absorbing the most energy followed by FHL and PB (P<0.05). Stiffness for the TA tendons (175.5 N/mm ± 94.8) was greater than FHL (43.3 N/mm ± 14.1) and PB (43.6 N/mm ± 18.9) which did not differ (Figure 2).

Figure 1: * P< 0.05 compared to TA

DISCUSSION
A number of tendons have been clinically successful in the repair and in the management of acute and neglected subcutaneous tears of the Achilles tendon [1-6]. Graft choice should consider surgical difficulty, post operative morbidity as well as mechanical properties. The mechanical findings in this study reveal FHL to be stronger than PB but they have similar stiffness. The mechanical properties of PB and FHL were both inferior to TA. The stiffness of the graft appears to be an important parameter rather than ultimate load of the graft based on the clinical success of both techniques.

REFERENCES

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Figure 2: * P< 0.05 compared to TA

Ultimate tensile load (Mean, SD)

Stiffness (Mean, SD)