Anatomical-histological study of the Achilles tendon: the search for sub-tendons

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Summary

The Achilles tendon is one of the most important tendons in the human body. According to some literature, it is characterized by the presence of three sub-tendons corresponding to the three separate triceps surae muscles. These sub-tendons have been reported using imaging techniques and dissection in human specimens and using histological samples in rats and rabbits. However, the concept of sub-tendons in human Achilles tendons remains controversial. The aim of this study was to attempt to identify the human Achilles sub-tendons in histological cross-sections and verify whether the previously reported rat and rabbit models could be confirmed in humans. For this purpose, Achilles tendon samples from fresh human cadavers (n = 10) were analyzed histologically after Masson's trichrome staining. We observed the presence of numerous fascicles of varying sizes and numbers in all samples. In no cases could three distinct components corresponding to three sub-tendons be observed.

Introduction

The Achilles tendon (AT) is one of the most important tendons in the human body: not only because it is the strongest tendon, but because it has played a crucial role in the history of evolution from apes to hominins. The AT has been described as having a unique anatomy, with three sub-tendons and rotated fibers [1,2]. The notion of sub-tendons was first introduced in 2016 [3] based on AT dissections, as well as studies showing the heterogeneity of this tendon [1, 4]. However, not all researchers agree. Maas et al. [5] for example, advise caution when using the word sub-tendon. It is true that these sub-tendons have been observed on a longitudinal histological section of rat AT and a transverse histological section of rabbit AT [6, 7], but no histological study has yet clearly shown these sub-tendons in humans. The aim of this study was to fill this gap and verify whether sub-tendons are present in human AT.

Methods

We dissected five pairs of fresh human AT (n=10). The length of each AT was measured from the point of fusion of the two gastrocnemii to the insertion on the calcaneus. Two samples were taken from each tendon: one at 40% of tendon length and another at 5 cm from the insertion on the calcaneum. The samples were embedded in paraffin wax and 5 µm sections were cut transversally. Masson trichrome staining was performed on cross-sections of the samples collected to perform a histological analysis.

Results and Discussion

We observed the presence of numerous fascicles of varying sizes and numbers in all samples (Figure 1). In the same specimen the number and size of fascicles varied not only according to location, but also according to side. In no tendon were we able to observe three distinct parts corresponding to three sub-tendons, which is in contradiction to previous studies in which the sub-tendons have been observed and separated during dissection. They have also been reported using Magnetic Resonance Imaging [8]. According to Handsfield et al., the sub-tendon is the largest subunit in the AT (unlike other tendons where the fascicle is the largest subunit of the tendon). The sub-tendon does not exist in all tendons; It has been reported specifically in muscles with several bellies, each forming a distinct sub-tendon. The previously reported AT sub-tendons have been suggested to have a diameter of 3-10 mm and are bound by the inter-sub-tendon matrix [8]. In our study, we were unable to observe a microscopic structure with a diameter of 3-10 mm within the tendon.

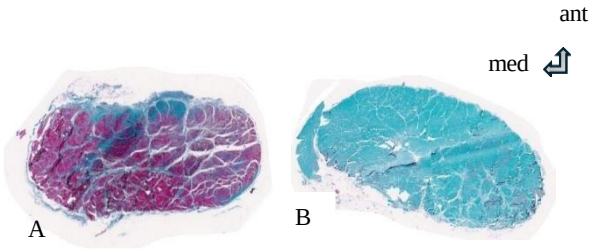

Figure 1: Transverse histological section of the right human Achilles tendon at 40% of length (A) and 5 cm proximal to the insertion on the calcaneus (B).

Conclusions

This histological study was unable to confirm the existence of AT sub-tendons in human cadaveric specimens.

References

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