

Fiber type differences in the surface area of the human myotendinous junction

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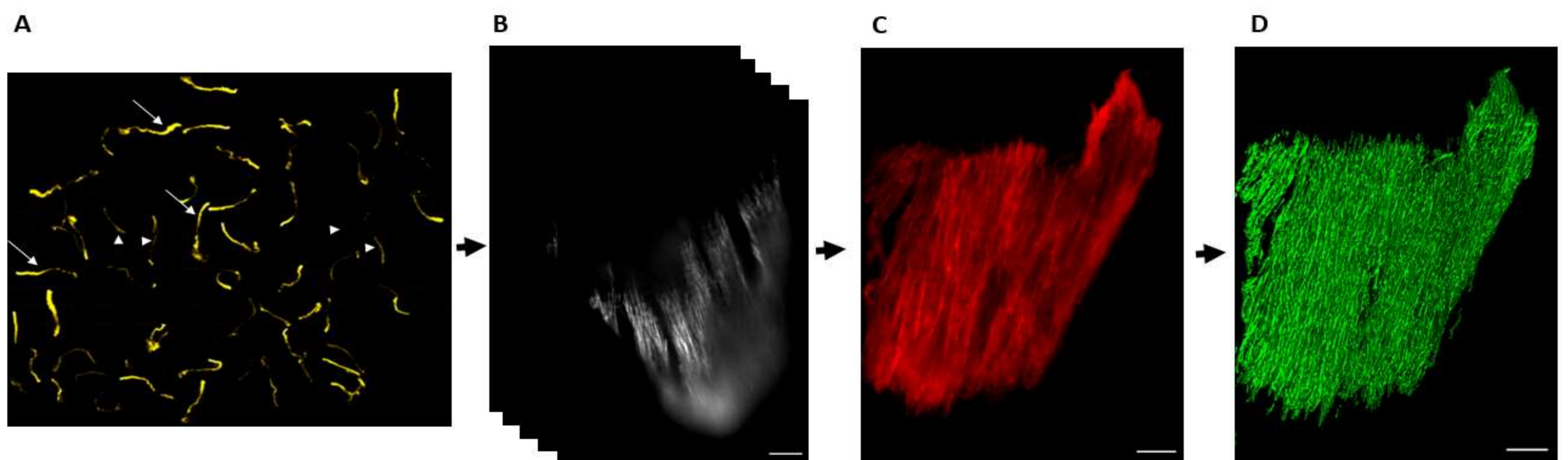
Background

The myotendinous junction (MTJ) is the interface between muscle and tendon but also where strain injuries most often occur. In order to sustain the large forces that are exchanged between muscle and tendon at the MTJ, the interface is folded to increase the contact area between the tissues. Theoretically, this improves the ability of the MTJ to withstand loading. There seems to be a higher risk of strain injury in hamstring muscles with a large proportion of type II fibers. We hypothesize, that this is due to differences between muscle fiber types in relation to the size of contact area between muscle and tendon.

Method

From human semitendinosus MTJs individual muscle fibres with intact MTJ were isolated by manual dissection and labelled with antibodies against collagen XXII (indicating MTJ) and type I myosin. Using a spinning disc confocal microscope, the MTJ of each fiber was scanned and reconstructed in a 3D-model. This reconstruction was used to measure the contact area.

Human muscle fibers from m. semitendinosus scanned with a confocal microscope and reconstructed into a 3D structure

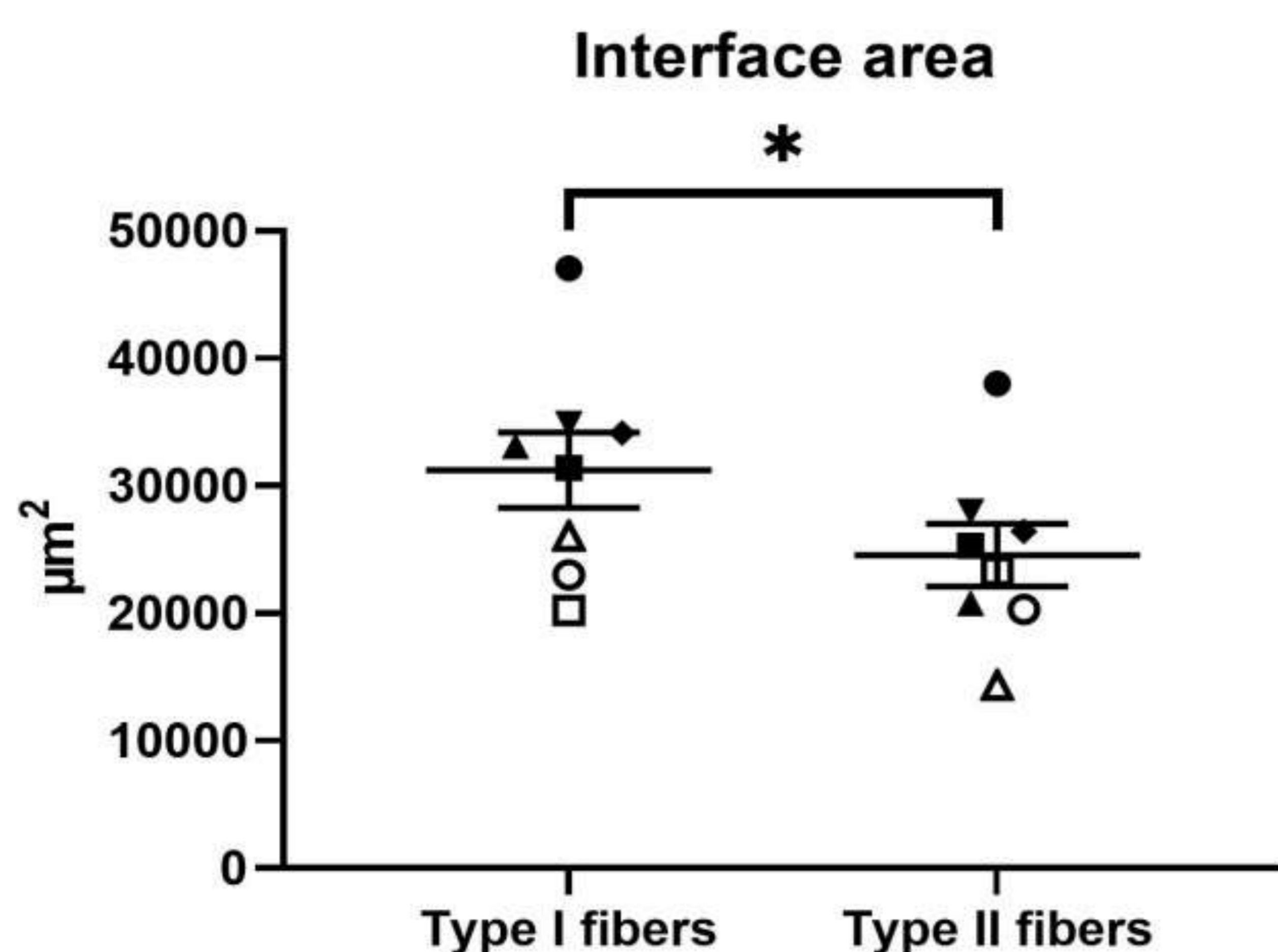


Analysis of MTJ from entire human muscle fibers

Before scanning individual fibers, the presence of myosin type I was noted for each fiber (A). In the spinning disc confocal microscope the collagen XXII labelled MTJ was imaged creating a stack of images (B). By compiling these images a 3D-structure was created (C). Based on this structure an artificial surface was created (D) by set threshold settings from which the surface area could be measured.

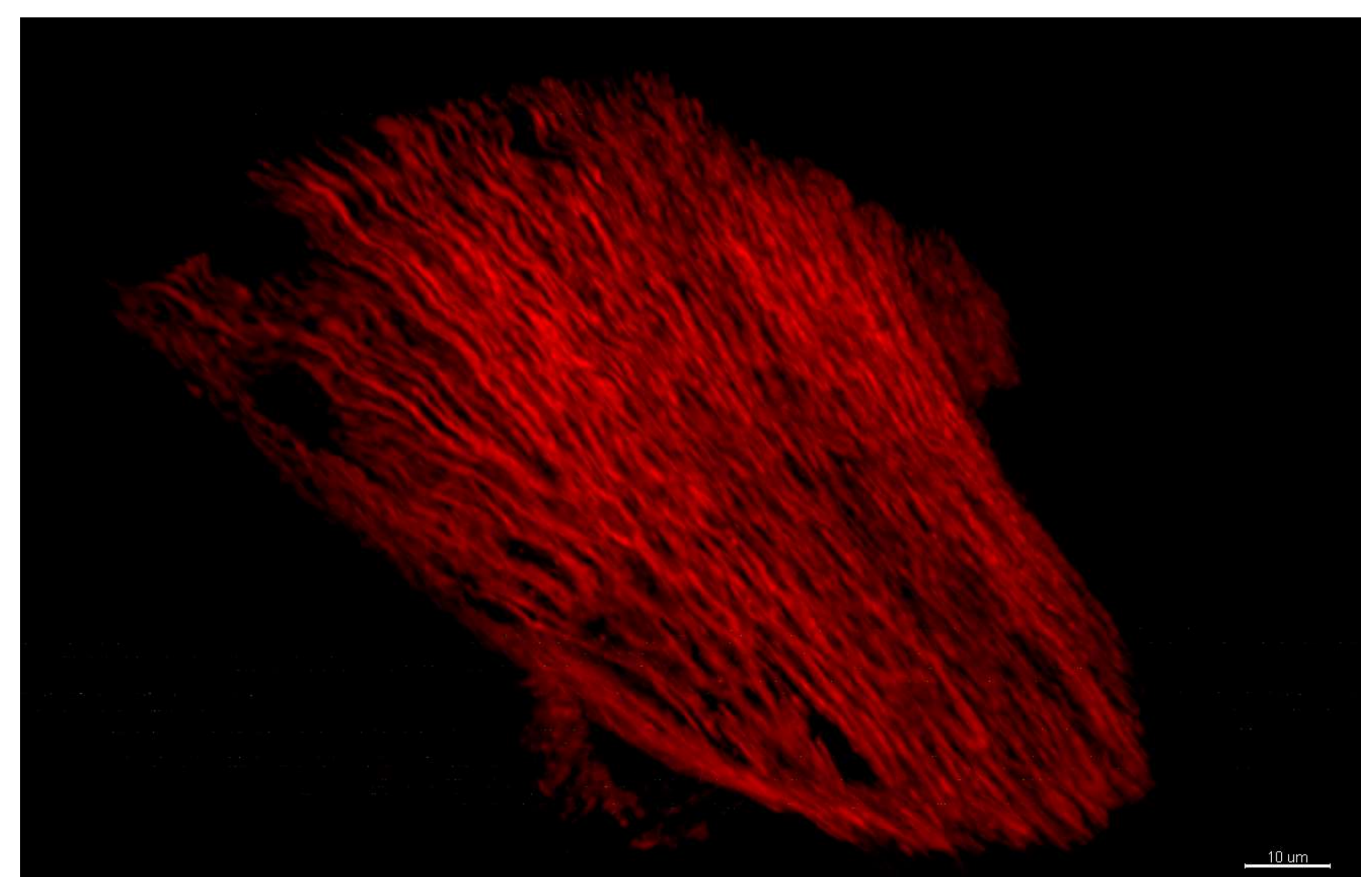
Results

The contact area at the MTJ in 314 muscle fibres was found to be significantly larger (22.3%) in type I compared to type II fibres.



Difference in MTJ surface area between muscle fiber types

Results of the measurements of the interface area of MTJ type I and type II fibers. Median values from each subject is represented by an individual symbol (Females are open symbols and males are closed). A significant difference is seen between the fiber types (P= 0.023).



3D stack showing the folded MTJ surface

The figure shows a Z-stack of images of collagen XXII stained foldings from a single human muscle fiber. Scale bar is 10µm

Conclusion

The contact area between muscle and tendon was higher in type I compared to type II muscle fibers. This difference could potentially affect the ability of the individual muscle fiber to withstand force thereby explaining why type II fibers seem to be more susceptible to strain injury.