The impact of filtering fascicle length data tracked using a semi-automated algorithm: a pilot study

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Summary

This pilot study investigated the impact of filtering fascicle length data obtained using a semi-automated tracking algorithm. This involved the collection of B-mode ultrasound (US) recordings of a synthetic fascicle, lengthened and shortened at a controlled velocity, and US recordings of human gastrocnemius medialis during cycling. Filtering fascicle length data following tracking has the potential to clearly alter the outcome of a study if fascicle length derivatives are of interest.

Introduction

Semi-automated tracking algorithms for US recordings [1,2] have provided us with a fast and suitable method to estimate meaningful variables such as fascicle length changes and fascicle shortening velocities with less human/operator input. Whilst like any other signal, US signal is expected to be contaminated with noise from a range of sources, researchers often fail to consider filtering US data. Furthermore, there is no consensus on how to reduce measuring and processing errors in dynamic US data as systematic and random errors are likely to be introduced before and during the fascicle tracking stage. Therefore, the purpose of this study was to establish a preliminary understanding of the impact of filtering fascicle length data obtained using a popular semi-automated tracking algorithm on both synthetic fascicles imaged in a controlled environment, and on human fascicles imaged in-vivo during cycling.

Methods

Firstly, we collected signals from a synthetic fascicle (polyester and spandex composite) that was lengthened and shortened at a rate of ±30 mm·s^{-1} through an approximate horizontal range of 20 mm, whilst a US scanner sampled the movement at 60 Hz. Secondly, we studied pre-collected *in-vivo* data from a right gastrocnemius medialis muscle, also collected at 60 Hz during cycling at an intensity of approximately 200 W and with a cadence of 92 rev·min^{-1}. Both US video conditions were processed by UltraTrack [1,2] and raw fascicle length measurements were filtered with an optimal low-pass Butterworth filter of 11 Hz. Raw and filtered fascicle length data, instantaneous length change and the rate of length change (lengthening/shortening velocity) were computed.

Results and Discussion

Filtering the synthetic ultrasound data had a minimal impact on mechanical variables such as fascicle range (<1%), although it had a greater impact on other derivates, such as peak shortening velocity (>28%; Figure 1). Filtering had a more profound impact on the *in-vivo* data, decreasing fascicle range by 9% and peak shortening velocity by 87% (Figure 1).

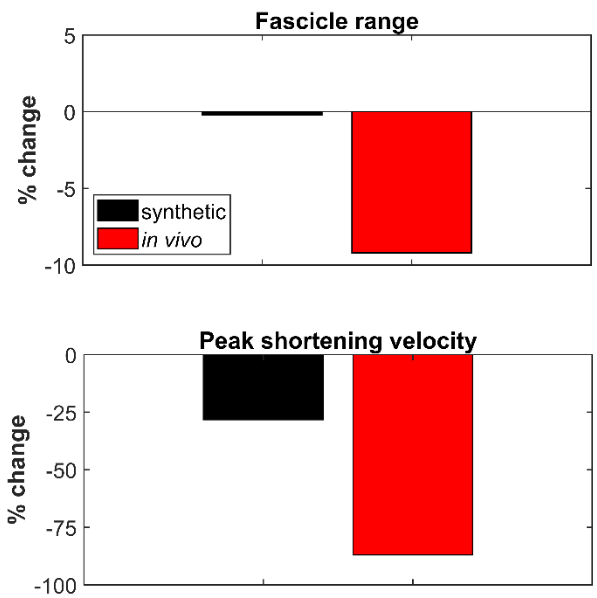

Figure 1: Percentage change from unfiltered to filtered data.

Filtering fascicle data made a minimal difference to the raw fascicle length-time curve in a controlled environment using a synthetic fascicle. Regarding the *in-vivo* condition, filtering produced a larger effect on both average and instantaneous variables. We believe that the *in-vivo* condition was more affected by variables related to data collection and analysis than the synthetic condition, which was more controlled.

Conclusions

Filtering impacted mechanical variables obtained from both synthetic and *in-vivo* data. The impact of filtering is more obvious when calculating derivatives and obtaining values at single, discrete time points. Future studies could consider filtering fascicle length data if derivatives such as shortening velocity are to be computed, as these derivates inform models of muscle contraction and movement economy.

References

[1] Cronin NJ et al. (2011). *JAP*, **111**: 1491-1496.
[2] Farris DJ and Lichtwark GA. (2016). *Comput Methods Programs Biomed Some Book,* **128**: 111-118.