Assessment of the effect of force application during ultrasonography of muscle thickness and architecture

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Summary

The effect of skin surface force application during skeletal muscle sonography was investigated. It was observed that minor changes (< 3N) in the applied ultrasound probe pressure changed the recorded muscle thickness and muscle fiber pennation angle. This highlights the importance of objective measurements of the applied probe pressure during ultrasonography to ensure unbiased results.

Introduction

Ultrasonography is a non-invasive, portable and cost-effective method of real-time tissue imaging. It is considered a valid method for assessing muscle function, architecture and composition and used for medical diagnostics, monitoring, and therapeutic purposes [1,2]. However, the operator dependent nature of the handheld scanning probe and the image interpretation can induce bias and lower reliability. Specifically, the applied force during scans constitutes a considerable source of inter- and intra-personal variation which potential can affect the obtained data. Therefore, the purpose of this study was to investigate the effect of the applied force to the skin through the ultrasound probe on the obtained images and extracted variables assessing muscle thickness and fiber pennation angle

Methods

Twenty-two healthy individuals (10 males and 12 females; 28.3 years ± 8.3; BMI: 22.3kg/m^2 ± 2.4) with no muscle-related injuries or disorders participated in the present study. Muscle thickness and fiber pennation angle were recorded using an ultrasound device (Sonoscape E2) from the vastus lateralis muscle with the participants in a supine position and the ultrasound probe (L741 linear probe) placed 10 cm above the patella bone-tendon attachment and from the medial gastrocnemius muscles with the participants in a prone position and the probe placed at the thickest muscle portion. Ultrasound images of the longitudinal and transversal sections of both muscles were obtained by the same operator using three different protocols (Figure 1): 1) The probe was hand held while applying no and maximal possible pressure to the skin surface, respectively; 2) The probe was connected to a crank lifter and a strain gauge enabling a gradually increase in applied pressure from 0 to 5 N; 3) The probe was connected parallel to a dynamometer measuring the pressure applied to simultaneously to the skin surface from 0 to 15N. For the first protocol, a paired Student's t-test was applied and for the second and third protocol a one-way repeated ANOVA was applied to investigate the effect of applied pressure.

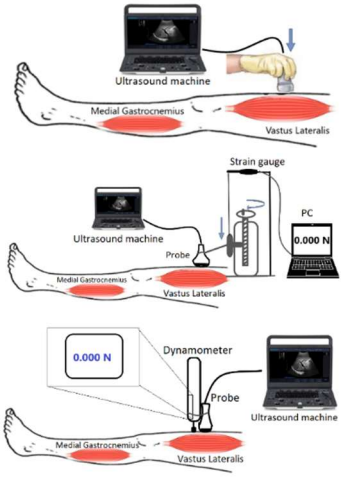

Figure 1: The three completed protocols.

Results and Discussion

There was a significant effect of applied pressure on both muscle thickness and fiber pennation angle for all three protocols and for both muscles (Figure 2; $p < 0.05$). Both thickness and pennation angle decreased with increase in applied probe pressure. Even small changes in pressure (< 3N) resulted in changes in the recorded muscle thickness and pennation angle. This indicates that the applied pressure through the probe to the skin surface can affect the outcome measures from ultrasonography.

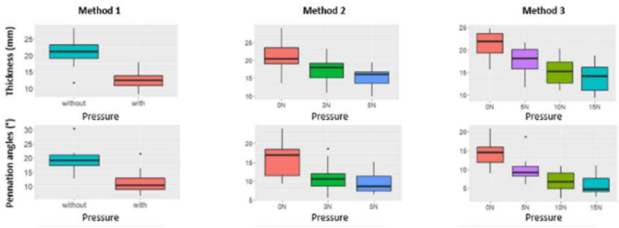

Figure 2: Thickness and pennation angle from vastus lateralis.

Conclusions

The present study highlights the importance of objective measurements of the applied ultrasound probe pressure to ensure unbiased results.

References

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[2] Pillen S and Alfen N (2011). *Neurol Res*, 33(10): 1016-1024.