ANALYSIS OF QUADRICEPS STRAIN RATIO BY QUASI-STATIC ELASTOGRAPHY

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INTRODUCTION

Muscle stiffness can be altered under pathological conditions and during aging process [1,2]. Stiffness assessment allows a better understanding of flexibility and improvement of musculoskeletal models [3]. Elastography is notable for allowing muscle stiffness evaluation in a non-invasive way and in real time.

Stiffness evaluation of healthy muscles is important to access the values of normality. Additionally, it becomes useful for choosing treatment protocols and to follow-up the injury stages. However, there is a lack of stiffness values available in the literature. The aim of the study was to characterize the strain of the rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM) muscles, bilaterally, by quasi-static elastography, and to compare the strain values between limbs.

MATERIALS AND METHODS

Nine subjects (males, n = 7), right-handed and physically active participated in the study (25.9 ± 4.0 years old), which was approved by the local ethics and research committee on humans (2.620.204).

An ultrasound coupled to a 6-15 MHz (55 mm) linear transducer was used to generate the elastography images. The subjects adopted the supine position to acquire the images of the RF, VL, and VM muscles at rest. The transducer was positioned longitudinally to the muscle fibers at 50% of thigh length (major trochanter-fibula head). Approximately 10 manual (transducer) compression cycles were applied using moderate pressure. Elastographic images were displayed by a color map superimposed on the B-mode image (Figure 1). The color scale ranged from red (higher strain) to blue (lower strain).

One video of 20 s (~150-200 strain values) was recorded for each muscle, totaling 6 videos per individual. Two circular regions of interest (ROI) with a diameter of 0.5 and 0.1 cm were selected in the central region of the muscle and adipose tissue, respectively. The strain ratio represents the ratio between muscle strain (ROI A) and reference region (fat) strain (ROI B), Figure 1.

Two-way ANOVA (side vs. muscle) and post hoc test were used to distinguish possible significant differences. The level of significance was α = 0.05.

RESULTS AND DISCUSSION

There was no significant interaction between the factors ($p > 0.05$), only for the muscle factor ($p \leq 0.05$). VL muscle had higher values of strain ratio than VM (left: 4.04 ± 0.94 *vs* 2.71 ± 0.96 and right: 4.17 ± 0.80 *vs* 2.27 ± 0.62, $p \leq 0.05$), respectively, on both sides, as shown in Figure 1.

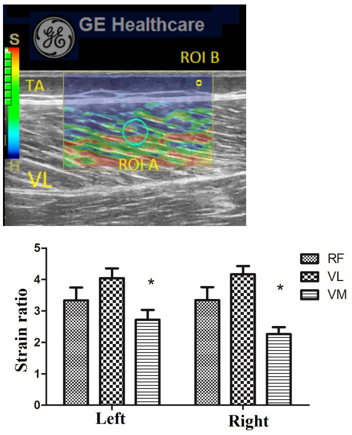

Figure 1 – Elastographic image of VL (image depth: 4 cm) and mean and standard deviation of the strain ratio for the rectus femoris (RF), vastus lateralis (VL) and vastus medialis (MV) muscles, bilaterally.
* Difference (p≤0.05) between VL and VM. TA: adipose tissue.

The results showed a similar muscle strain between the sides, which seems to exclude the greater loading in the dominant limb (laterality influence). VM showed lower strain ratio (higher strain) values compared to VL, on both sides.

CONCLUSION

Quadriceps muscles present similar strain between the sides at rest, however the VM deforms more than the VL.

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