

## A reliable protocol for shearwave elastography of lower limb muscles at rest and stretched

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### Introduction:

*In vivo* assessment of muscle properties is essential both for musculoskeletal modelling and clinical diagnosis. Shearwave elastography (SWE) allows non-invasive quick estimation of muscle shear modulus *in vivo* [1]. However, there is lack of consensus about the protocol, which has to be standardized for a clinical routine use. The aim of this study is to propose a measurement protocol using SWE and to assess its reliability.

### Materials and Methods:

Four positions were chosen to evaluate shear modulus in the anterior and posterior limb, at rest and under passive stretching (Supersonic Imagine, Aix-en-Provence, France). 10 healthy subjects were considered (age: 25.5±2.8).

1. Supine, legs and knees outside, 90° angle between leg and thigh (figure 1a),
2. Sitting, 90° angle between trunk and thighs (figure 1b),
3. Prone, foots outside (figure 1c),
4. Prone, 90° angle between leg and thigh (figure 1d).

Reliability was investigated for 2 muscles (vastus medialis, VM and gastrocnemius lateralis, GL) (3 observers, 6 repetitions each) and because it was time consuming 2 observers, 3 repetitions were considered for 11 muscles (biceps femoris, gracilis, rectus femoris, sartorius, semimembranosus, semitendinosus, vastus lateralis and medialis, gastrocnemius medialis and lateralis, soleus). Operators were familiar with muscles ultrasonography and probe was replaced between each measurement. Tissue deformation was limited with a large amount of gel. The position influence was studied using Wilcoxon signed-rank.

### Results and Discussion:

Pooling VM and GL, reproducibility and repeatability were 0.5 and 0.4 kPa. The 95% Confidence Interval (95% CI) was below 0.8 kPa at rest and below 1.4 kPa stretched. For the 11 others muscles, 95% CI were lower than 1.6 and 3.2 kPa respectively at rest and stretched. Quadriceps muscles and Gastrocnemius muscles were the most reliable (95% CI <2.4 kPa). Shear modulus was significantly higher when muscle was stretched than at rest ( $p < 0.05$ ). Positions did not influence significantly the reliability ( $p = 0.83$ ). SWE appeared as a reliable tool to evaluate shear modulus of lower limb muscles with the proposed protocol.

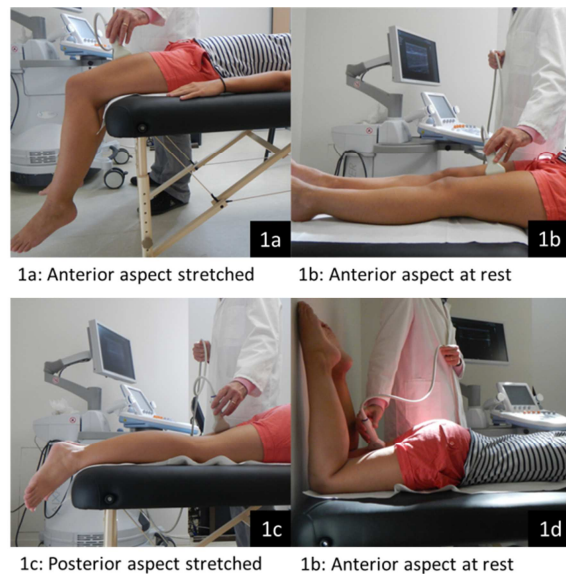


Figure 1 Measurement position during assessment of shear modulus at rest and stretched