*Keywords* Paresis; Cocontraction; Contracture; Muscle stretch
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## Reliability of 2D ultrasound imaging associated with transient ShearWave Elastography method to analyze spastic gastrocnemius medialis muscle architecture and viscoelastic properties

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*Purpose* The aim of the study was to assess the reliability of pennation angle (PA) and muscle thickness (MT) 2D measurements and of shear elastic modulus measurement, using ultrasound imaging (US). Those measurements were made on spastic gastrocnemius medialis muscle at rest and at maximal passive stretching, in post-stroke hemiplegic patients. The paretic side measurements were compared to non-paretic side.
*Material and methods* Fourteen patients took part in 2 inter-session reliability experiments, realized at a 7 days interval by the same operator. The Aixplorer® Supersonic US scanner with the transient ShearWave Elastography (SWE) software was used. The stretching experiments were made manually and controlled by a goniometer.
*Results* The reliability of the 2D measurements was good. The coefficient of variation (CV) was 6.30% for MT measurement at rest, 6.40% and 8.26% for PA at rest and at maximal passive stretching respectively. The reliability of the shear elastic modulus measurement in the sagittal plane was good only at rest with a CV of 9.86%, versus 40.58% at stretching. None of the shear elastic modulus measurements in the axial plane were good. At rest, MT and PA were weaker on the paretic side ($14.25 \pm 3.12$ mm and $17.32 \pm 5.10°$) versus non-paretic side ($16.30 \pm 3.19$ mm and $21.08 \pm 5.05°$) ($P < 0.0001$ and $P = 0.006$). At rest, there was a small difference in the shear elastic modulus between the paretic side and the non-paretic side ($5.40 \pm 1.67$ kPa versus $6.20 \pm 2.18$ kPa, $P = 0.041$).
*Discussion* This is the first description of muscle spastic structure using SWE with Supersonic Shear Imaging. 2D US associated with SWE shows promise in terms of muscular atrophy quantification and muscle histological quality assessment. These structural properties reflect some of the functional abilities regardless of motor control. It should enable further research on therapies, which impact muscle tissue quality, such as botulinum neurotoxin injections.
*Keywords* 2D ultrasound imaging; Transient ShearWave Elastography; Spastic muscle; Structure; Reliability
*Disclosure of interest* The authors have not supplied their declaration of conflict of interest.

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## Role of the mechanic muscular injury in the development of heterotopic ossifications. A study on an animal model

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*Introduction* Optimising the first model developing heterotopic ossification (HO) on paraplegic mouse requires the study of cardiotoxin intramuscular injection substitution by a mechanical injury. Two lines of research were developed: pressure by extended crush and brief high-energy physical impact, with and without IM injection of LPS (purified bacterial lipopolysaccharides).
*Material* The first kind of mechanical injury evaluated was the crush with a pressure manometer Jamar®. The hamstring of the hind limbs of five groups of paraplegic mice underwent pressure forces from 2.5 to 10 kg with compression length going from 5 to 25 seconds. The second involved a brief high-energy physical impact on thigh muscles through an impactor, making possible a defined and reproducible soft tissue contusion. The hamstring of hind limbs of 2 subgroups of paraplegic mice underwent 2 different forces of muscular impact (energy for impact 1 = 0.19 J & for impact 2 = 0.32 J). In these two experiments, a spinal cord injury of T6 level was made, associated or not to LPS injection. The presence and the volume of the HO was measured by μCT after fixation and decalcification.
*Results* There was no HO: (1) in the different groups after muscular crush and in the control groups with and without injection of LPS in the hamstring. (2) Neither in the brief high-energy impact without LPS groups.
On the other hand, we found HO in the hamstrings of the brief high-energy impact with LPS injection group ($n = 7$ mice) (mean volume: 0.355 $mm^3$ for impact 1 and 0.76 $mm^3$ for impact 2; mean density: 209.75 mg HA/$cm^2$ for impact 1 and 265.5 mg HA/$cm^2$ for impact 2).
*Discussion* A brief high-energy impact could contribute to the damage mechanism favouring HO development. Extended muscular crush doesn't seem to be involved. LPS role needs to be specifically study because it injection has to be associated with the brief high-energy impact.
*Keywords* Heterotopic ossification; Muscular crush; Physical impact; LPS; Mouse
*Disclosure of interest* The authors have not supplied their declaration of conflict of interest.
*Further reading*
Genêt et al., Neurological heterotopic ossification following spinal cord injury is triggered by macrophage-mediated inflammation in muscle. J Pathol 2015 Feb 25.

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