Measuring the effects of acupuncture on muscle stiffness with shear wave elastography

BACKGROUND

Acupuncture has been found to relieve muscle stiffness effectively , especially after physical exercise.[1,2] Previous studies have measured muscle stiffness pre- and post-acupuncture using a pressure scale[1] or 'muscle hardness meter'.[2] Both of these methods estimate muscle stiffness based on the pressure required to compress muscle. Limitations of these devices include potential inaccuracy of measurement, as the distribution of muscle stiffness may be heterogeneous, as well as inability to visualise the muscle. Furthermore, changes in muscle stiffness during acupuncture needling cannot be evaluated. An ultrasound-based shear wave imaging technique has recently been developed to measure muscle stiffness.[3] Benefits of using ultrasound include the ability to visualise the muscle under investigation and to quantify changes in muscle stiffness over time. Ultrasound as an imaging modality has many potential uses in acupuncture research and education,[4] and can be successfully used to explore its physiological and physical effects.[5] The aim of this study was to measure the effects of acupuncture needling on muscle stiffness using shear wave elastography.

METHODS

Acupuncture needle insertion

We performed acupuncture needle insertion on two healthy volunteers (one male, one female) who were part of the study team. The acupuncture point used in this study was BL58 (*Feiyang*), which is located on the posterior aspect of the lower leg behind the external malleolus. Acupuncture at BL58 has been reported to help relieve leg cramps. The volunteers lay prone on a couch during insertion of a 0.30×50 mm disposable stainless steel acupuncture needle (Hanyi) at a 90° angle to the skin and to a depth of 1–1.5 *cun*.

Ultrasound scanning

The ultrasound scans were performed using a Toshiba Aplio 500 system (Toshiba Medical Systems, Otawara, Japan) that was equipped with a 14L5 (PLT-1005BT) high frequency linear probe (centre frequency of 10 MHz). Aquasonic 100 gel was used as the coupling agent. Shear wave elastography was used to quantitatively measure muscle stiffness. An elastography map was used to visualise and quantify the shear wave propagation velocity, and propagation mapping was used to assess the quality of the elastogram (figure 1). The medial gastrocnemius muscle (part of the bilateral triceps surae muscle) was chosen due to its distinct activity during muscle strain.

Experimental steps

The medial gastrocnemius muscle was initially identified under ultrasound guidance in the transverse plane. At this point, measurements of muscle stiffness (at rest) were performed. This was followed by needle insertion by the acupuncturist. The acupuncturist manipulated the needle until she felt mechanical changes in the tissues and the subjects verbalised having experienced the *de qi* sensation. The needle was left stationary and retained for 30 min before removal.

Data collection and analysis

Muscle stiffness was measured at baseline, immediately post-insertion, and then at 5 min intervals during needle retention up until 10 min post-needle removal. Four muscle tension values were obtained from each scan. Altogether, eight values were obtained at each time point, and the median and IQR were calculated. Data were compared between the two subjects using the Friedman test.

FINDINGS

Immediately after needle insertion and 5 min later (time period incorporating manual stimulation), muscle stiffness appeared to increase in both subjects (figure 2). Between 5 and 10 min post-needle insertion, muscle stiffness appeared to decline and plateau at a level that remained relatively consistent throughout the period of needle retention. There was no statistically significant difference in measurements between the two subjects at any time point ($p>0.05$). Following needle removal, muscle stiffness was lower relative to baseline in the male, but higher in the female.

COMMENTS

To the best of our knowledge, this study is the first to assess the stiffness of the gastrocnemius muscle after acupuncture at BL58 using shear-wave elastography. Although larger scale validation is required, our study

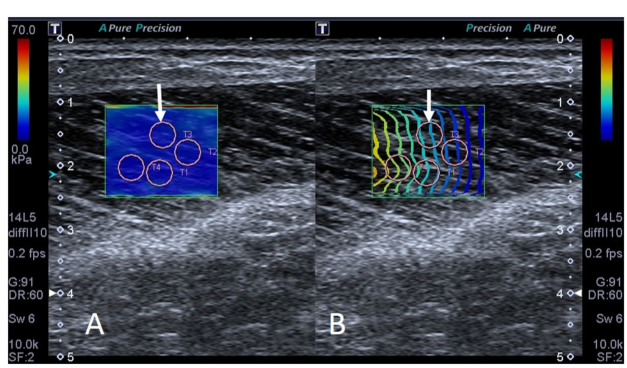

Figure 1 Shear wave elastography of the gastrocnemius muscle in a longitudinal plane. Rectangular field of view demonstrating good quality shear-wave elastogram as indicated by homogeneously distributed blue colour-coded muscle (A) and evenly spaced propagation waves (B). Quantitative analysis of gastrocnemius muscle stiffness was achieved by placing the small circular regions of interest (ROIs; illustrated by arrows) over the elastography map.

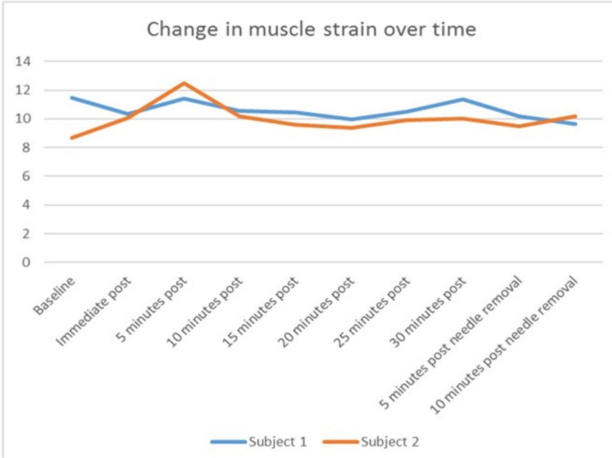

Figure 2 Change in muscle strain (measured by shear-wave elastrography) over time in two healthy subjects undergoing acupuncture at BL58.

suggests that shear wave elastography is feasible and could be used as an objective measure of the effects of acupuncture on muscle stiffness. Although previous studies have reported that acupuncture is effective at reducing muscle stiffness,[1 2] our study was inconclusive in this respect as the muscle stiffness of the female subject was actually higher after acupuncture compared with her baseline. This inconsistency, as well as the lack of statistically significant differences between individual time points in these subjects, is likely to reflect the very small sample size. It should be noted that an increase in muscle stiffness could also be associated with factors unrelated to needling *per se*, such as anxiety surrounding the initial experience of acupuncture. Larger studies need to be conducted to elucidate the effects of acupuncture on muscle stiffness.

A consistent and noteworthy finding between both subjects was the apparent spike in muscle stiffness 5 min post-needle insertion, which was followed by a gradual decrease. This appears to challenge the common belief that acupuncture immediately reduces muscle stiffness after insertion. Future studies should also explore both the immediate and longer-term effects of acupuncture on muscle stiffness.

Mabel Qi He Leow,[1] Shu Li Cui,[2] Taige Cao,[3,4] Shian Chao Tay,[1,5,6] Chin Chin Ooi[7]

[1]Biomechanics Laboratory, Singapore General Hospital, Singapore, Singapore
[2]Pain Management Centre, Acupuncture Services, Singapore General Hospital, Singapore, Singapore
[3]Medical Department, National Skin Centre, Singapore, Singapore
[4]Singapore College of Traditional Chinese Medicine, Singapore, Singapore
[5]Department of Hand Surgery, Singapore General Hospital, Singapore, Singapore
[6]Duke-NUS Medical School, Singapore
[7]Department of Diagnostic Radiology, Singapore General Hospital, Singapore, Singapore

Correspondence to Dr Mabel Qi He Leow, Biomechanics Laboratory, Singapore General Hospital, Academia, Level 1, 20 College Rd, Singapore 169856, Singapore; mabelleowqihe@yahoo.com

Contributors ML, TC and CCO conceptualised the study. ML performed the data analysis. CCO performed the ultrasound scans. SLC performed the acupuncture intervention. All authors were involved in manuscript writing and approved the final version accepted for publication.

Funding This study was funded by the Biomechanics Laboratory Programme Grant and the SingHealth Duke-NUS Academic Medical Centre, and facilitated by the Joint Office of Academic Medicine (JOAM). It is an initiative of Surgery Academic Clinical Programme (SURG ACP), hosted at the Singapore General Hospital (SGH).

Competing interests None declared.

Provenance and peer review Not commissioned; internally peer reviewed.

To cite Leow MQH, Cui SL, Cao T, *et al*. *Acupunct Med* Published Online First: [please include Day Month Year]. doi:10.1136/acupmed-2016-011322

Accepted 23 April 2017

Acupunct Med 2017;**0**:1–2.
doi:10.1136/acupmed-2016-011322

REFERENCES

1 Lin JG, Yang SH. Effects of acupuncture on exercise-induced muscle soreness and serum creatine kinase activity. *Am J Chin Med* 1999;27(3-4):299–305.
2 Sato T, Hisamitsu T, Sato M, *et al*. Evaluation of the acupuncture needling effect on post-exercise muscle stiffness by newly devised muscle hardness meter. *The Showa University J Med Sci* 1992;4:135–40.
3 Shinohara M, Sabra K, Gennisson JL, *et al*. Real-time visualization of muscle stiffness distribution with ultrasound shear wave imaging during muscle contraction. *Muscle Nerve* 2010;42:438–41.
4 Leow MQ, Cao T, Lee SH, *et al*. Ultrasonography in acupuncture: potential uses for education and research. *Acupunct Med* 2016;34:320.2–2.
5 Leow MQ, Lee SH, Mohamed Shah MT, *et al*. Exploring the physiological and physical effects of acupuncture using ultrasound. *Acupunct Med* 2016:acupmed-2016-011274.

AIM

Measuring the effects of acupuncture on muscle stiffness with shear wave elastography

Mabel Qi He Leow, Shu Li Cui, Taige Cao, Shian Chao Tay and Chin Chin Ooi

Acupunct Med published online June 17, 2017