

RELIABILITY OF HAND-FREE ULTRASOUND MEASUREMENT FOR VASTUS MEDIALIS OBLIQUUS

Y.M. Wong, G.Y.F. Ng
Dept. of Rehabilitation Sciences
The Hong Kong Polytechnic University
e-mail: rswongym@polyu.edu.hk

INTRODUCTION

Atrophy of the vastus medialis obliquus (VMO) muscle is relatively common among patients with patellofemoral pain syndrome. In order to monitor the effectiveness of rehabilitation program for strengthening the muscle, clinicians may measure the distal circumference of the thigh with tape. However, the distal thigh contains VMO as well as other muscles, the circumference measurement may not precisely address the change for the VMO muscle.

B-mode ultrasound can visually quantify muscular cross-sectional area, and is usually controlled by the operator manually holding the ultrasound probe. However, little has been done to reveal the reliability of such measurement for the VMO. Electromagnetic tracking (e.g. pciBird, Ascension, USA) and 3D digitizing (e.g. Microscribe, Immersion, USA) instruments have been used to ensure accurate positioning of the ultrasound probe at the same muscle for periodical scanning. Despite the costs of these positioning devices, the accuracy of the electromagnetic tracker is susceptible to adjacent metal (e.g. hospital bed) and a lack of mobility of the 3D digitizer is not very compatible to clinical settings.

The present study aimed (1) to design a hand-free ultrasound system with economic and portable manner; (2) to examine the reliability of the system for measuring the VMO cross-sectional area by comparing it with a gold standard and between-day measurements.

METHODS

Design: A custom-made mechanical stand adjustable in height and tilt angle was used to statically hold an ultrasound probe (Voyager, Ardent Sound, USA) (fig 1).



Figure 1: Ultrasound probe holder

A laser pointer projected a cross mark at the suprapatellar level and a sliding ruler was used to measure the distance between the sole of feet and the suprapatellar border (fig 2). The distance and laser-cross acted as landmarks for the repeatable positioning of the ultrasound probe while a subject supine lying with knee extended and feet secured.

Figure 2: Cross-section locator



An ultrasound gel pad (Aquaflex, Parker Lab, USA) was molded to match the shape of the ultrasound probe and the VMO underneath. The pad weighed about 15g, thus it would not deform the VMO significantly (fig 3).



Figure 3: B-mode ultrasound

Testing procedures: Twelve VMO muscles (6 healthy volunteers, 4 males & 2 females) at suprapatellar level were imaged using the B-mode ultrasound and MRI (Magnetom Avanto, Siemens AG, Germany) within 3 hours. Both set of the images were saved in DICOM format for offline comparison of the cross-sectional area of VMO (fig 4).



Figure 4: VMO in ultrasound and corresponding MRI image

The twelve VMO muscles were ultrasonically scanned at one week later. Intraclass correlation coefficient ($p=0.05$) was calculated for the consistency of the two sets of the VMO cross-sectional area.

RESULTS

The mean difference was 5.7% (SD=3%) between the VMO measurement based on the ultrasound and MRI images (12 knees). The ultrasound method slightly underestimated the muscle size compared with the MRI.

The ICC result for the 7-day interval for the VMO ultrasound measurement (12 knees was 0.96 (95% CI=0.89-0.99).

DISCUSSION

Results of this study reveal that the hand-free ultrasound measurement to be comparable with MRI measurements and the system has satisfactory between-day repeatability for the VMO muscle. The application should not be limited to the VMO; it is potentially applicable to other skeletal muscles for diagnostic or biofeedback training purpose.