Journal of Bodywork & Movement Therapies (2014) 18, 266–272

Available online at www.sciencedirect.com

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journal homepage: www.elsevier.com/jbmt

FASCIA SCIENCE AND CLINICAL APPLICATIONS: DIAGNOSTIC ULTRASOUND IMAGING RELIABILITY

Rehabilitative ultrasound imaging of the supraspinatus muscle: Intra- and interrater reliability of thickness and cross-sectional area

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Received 18 March 2013; received in revised form 17 September 2013; accepted 18 September 2013

KEYWORDS
Sonography;
Morphometry;
Supraspinatus muscle;
Reliability;
Rehabilitative ultrasound imaging

Summary *Objective:* To examine intra- and interrater reliability of thickness and cross-sectional area (CSA) measurements of the supraspinatus muscle using rehabilitative ultrasound imaging (RUSI).
Methods: Two physical therapists acquired b-mode images of the supraspinatus muscles in twenty-five healthy subjects. Thickness and CSA were measured. Intra- and interrater reliability were examined.
Results: Intrarater reliability for thickness was high, ($ICC_{1.1}$ 0.91) for rater 1 and ($ICC_{1.1}$ 0.92) for rater 2. Intrarater reliability for CSA was also high, ($ICC_{1.1}$ 0.90) for rater 1 and ($ICC_{1.1}$ 0.85) for rater 2.
Interrater reliability for the thickness was high, ($ICC_{3.1}$ 0.86). For CSA, interrater reliability was moderate, ($ICC_{3.1}$ 0.70).
Conclusion: Supraspinatus muscle thickness and CSA can be reliably measured by physical therapists in healthy subjects. These findings confirm that RUSI has an interesting potential for

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http://dx.doi.org/10.1016/j.jbmt.2013.09.009

physiotherapy clinical practice, especially to assess morphometric changes in skeletal muscles. Further research is needed in subjects with shoulder disorders.

Introduction

Rehabilitative ultrasound imaging (RUSI) for musculoskeletal rehabilitation has been rapidly developed in the last 30 years (Whittaker et al., 2007). Throughout the world, especially in Australia, the USA and northern Europe, RUSI is commonly used by physical therapists because due to its safe, portable, objective, and relatively inexpensive means of examination (Whittaker et al., 2007).

Physical therapists employ RUSI as a procedure to evaluate muscle and related soft tissue morphology and function while subjects exercise and perform physical tasks. It is also used to assist in the application of therapeutic interventions designed to improve neuromuscular function. Indeed, physical therapists use this technology to provide biofeedback during treatment or to evaluate muscle architecture (morphology) (Teyhen, 2006; Whittaker et al., 2007).

Assessing pelvic floor, abdominal wall, and paraspinal muscle function are the most explored application of RUSI. The purpose is to correlate functional impairments with clinical conditions like neck, low back, and pelvic-girdle pain. For physical therapists, biofeedback can be a useful technique to assist in the application of therapeutic interventions and evaluate clinical outcomes. Most of the studies regarding morphometry have evaluated muscles in the axial skeleton (Costa et al., 2009; Ferreira et al., 2011; Hides et al., 2007; Javanshir et al., 2011; Lin et al., 2009; Norasteh et al., 2007; Stokes et al., 2007); few studies have been performed in appendicular skeleton muscles (Bemben, 2002; Cameron et al., 2008; English et al., 2012; Noorkoiv et al., 2010a; Reeves et al., 2004).

After back and neck disorders, shoulder complaints are the third most common reason for musculoskeletal consultation in primary care (Docimo et al., 2008). Common shoulder and rotator cuff problems are: rotator cuff tear, impingement syndrome, and instability. Rotator cuff disease is one of the most prevalent orthopedic conditions (Jerosch et al., 1991), and may affect as many as 20–30% of individuals between 60 and 80 years old and up to 50% of patients older than 80 (Carbone et al., 2012; Jerosch et al., 1991; Milgrom et al., 1995; Sher et al., 1995). Physical therapists are frequently involved in the conservative and postoperative treatment of rotator cuff muscles, especially the supraspinatus muscles. Employing RUSI to evaluate morphological changes in cross-sectional area (CSA) and thickness may be useful during strengthening and stability programs. This tool can monitor an intervention and may be used to assess specific clinical outcomes. From a clinical perspective, physical therapists as well as other clinicians can use RUSI like a reliable tool for monitoring and assess changes in muscle trophism. Additionally the outpatients' compliance can increase if visual and measurable muscle parameters are available during their treatment plan. Furthermore physical therapists can use this tool to objectify treatments improvements with healthcare funding institutions.

The aim of this study was to investigate the intra- and interrater reliability of RUSI to measure supraspinatus thickness and CSA.

Methods

Subjects

Twenty-five healthy subjects (11 female, 14 male) participated in the study. The mean ± standard deviation (SD) age, height, and weight were 27.2 ± 5.9 years, 174.4 ± 8.6 cm, and 68.9 ± 12.7 kg, respectively. Inclusion criteria were asymptomatic shoulders and no previous shoulder or neck surgery. Exclusion criteria were any neuromuscular or rheumatic conditions. Informed consent was obtained from each subject, and the rights of human subjects were protected.

Procedure

An ultrasound (US) device (MyLab25 gold, Esaote, Genoa, Italy) with a 13-4 MHz linear array (LA523) was used in this study. US device was calibrated prior to the study. Left and right supraspinatus muscle were analyzed twice for each subject by two raters. Neither rater had previous RUSI experience, and each completed a 6-h training session under the supervision of a radiologist. The aim of this training was to understand image generation, recognition, and measurements using ROI, especially for the supraspinatus muscle. Prior to data collection, both raters were required to perform practice exercises to improve their measurement skills.

For the actual assessment, three subjects were analyzed in each of eight sessions. Two measurements (test–retest) were performed in the same day to estimate intrarater reliability and to ensure that the muscular parameters were unchanged. The subjects were seated on a chair with their arms lying along their sides; the palms were facing the body, and the head and neck were in a neutral position. Thickness and CSA were measured for each muscle, and examination order was randomized.

To obtain thickness, the spine of the scapula was identified by palpation, and the probe was placed horizontally and superiorly to it (Fig. 1A).

The supraspinatus has been visualized in the bottom of the b-mode image and it is easily identifiable because of its triangular shape. Thickness was measured at 20.0 mm from the angle formed by the superior muscular fascia of the supraspinatus and the medial part of the supraspinous fossa (Fig. 1B).