INTRODUCTION

Medical sonography covers a broad spectrum of specialty areas including vascular sonography, cardiac sonography, and obstetric sonography. Because medical sonography covers such a broad array of clinical needs without the use of ionizing radiation, it has become essential in the diagnosis of many life-threatening diseases [1].

Although sonography is an indispensable tool, it is not without shortcomings. Every year more than 80% of clinical sonographers experience some form of musculoskeletal related pain, with up to 20% suffering from career ending injuries [1, 2]. These statistics make sonographers among the highest at risk groups for work-related musculoskeletal disorders (WRMSDs).

Current research points to the poor ergonomics of the ultrasound transducer as the main factor in the cause of WRMSDs. The awkward upper extremity positions required, the repetitive nature of the movements and the static aspect of the transducer grip have all been implicated in the development of WRMSDs [3].

The purpose of this study was to quantify wrist range of motion and muscle activation during scanning using two different standard ultrasound transducers. The data will be used to inform design of more ergonomic ultrasound transducers.

METHODS

Muscle activation and joint angle data were collected from six subjects while using both large and small ultrasound probes. The two probes selected represent a large number of designs currently on the market. Each trial consisted of scanning a fetal phantom for three different fetal measurements. Subjects performed three trials per probe condition.

Electromyographic (EMG) data were recorded for four wrist/hand muscle groups: extensor carpi group, flexor carpi group, flexor pollicis group, and the flexor digitorum superficialis at 1000 Hz. Wrist flexion/extension and radial/ulnar deviation angles were collected with an electronic goniometer at 50 Hz.

The goniometer used to measure wrist motion was a custom designed device using a high precision joystick potentiometer. The base of the potentiometer was attached to the forearm, proximal to the wrist joint. The joystick of the potentiometer was attached to the backside of the hand, distal to the wrist joint.

Subjects first performed trials to determine the MVIC for each of four muscle groups. A single test which involved gripping a rigid ball at maximal effort was used to quantify the flexor pollicis group and flexor digitorum superficialis MVIC’s. Resisted wrist flexion and extension were used to find the MVIC for the flexor and extensor carpi groups. Three trials were performed per muscle group. One static and three dynamic trials were performed for each of two probe sizes (large and small). Each dynamic trial consisted of a fetal ultrasound scan using a fetal phantom.

EMG data from the dynamic trials were bandpass filtered (20-450 Hz), and normalized to maximum voluntary isometric contraction (MVIC). Mean normalized maximum activation values for each condition were determined from group averages. A
paired, two-tailed t-test was performed for each of the muscle groups to determine if any differences were present in muscle activation between small and large probes.

RESULTS AND DISCUSSION

Muscle activation values were high for both probe conditions, especially in the pollicis group, where mean activations were 70-80% MVIC (Figure 1). There were no statistical differences in muscle activation level between the two probe sizes (p > 0.5 for all conditions). The wrist ranges of motion were only 2-6° for ulnar and radial deviation (Figure 2) and 3-14° for extension and flexion (Figure 3), which indicates a nearly static wrist position during fetal scanning.

During the performance of an ultrasound scan, the demand on the thumb gripping musculature is high, likely due to the relatively narrow waist of the transducers. Sonographers are forced to use an isometric pinching-style grip to stabilize the transducer probe against the patient’s body while scanning.

Ultrasound probes should definitely be redesigned to be more ergonomic. To reduce the incidence of wrist pain in sonographers, the primary focus of these efforts should be reducing the amount of muscle activation needed for gripping the device with the wrist in a relatively neutral position.

REFERENCES


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