Vertebral landmark visualization with portable ultrasound imaging in scoliosis monitoring

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Introduction. In scoliosis monitoring, X-ray imaging is traditionally used to visualize the spinal column of the patient to assess spinal curvature progression. Frequent screening is necessary to determine if spinal curvature has progressed such that bracing becomes necessary, as conservative treatments are preferred to avoid the need for corrective surgery later on. However, cumulative radiation exposure increases the risk of tumor development, and discourages frequent curve monitoring. Tracked ultrasound is a safe imaging alternative that relies on the precise identification of vertebral landmarks, but bones have reduced visibility in ultrasound imaging and high quality ultrasound machines are often expensive and stationary. In this work, we offer quantitative confirmation of equivalency between the Telemed MicrUs EXT-1H (Vilnius, Lithuania, EU), a portable USB ultrasound costing $4,000, and the standard $80,000 Sonix Touch (Analogic Corp., Peabody, MA, USA) in visualizing transverse processes for the measurement of transverse process angles (TxA), which can be used for spinal curvature measurement.

Methods. Two ultrasound machines were tested on three human subjects, using the Ascension 3D trakSTAR (NDI, Waterloo, ON, Canada) electromagnetic tracking system and 3D Slicer software. Spinal curves were measured in the same reference coordinate system for both ultrasound machines in 3D Slicer's Scoliosis module. Transverse process angles (TxA), were defined as lines connecting the left and right transverse process on the same vertebrae (1). Spinal curvature was then obtained from the angle between two such TxA-s, which were projected onto the coronal plane. Three experienced observers localized transverse processes as skeletal landmarks and obtained TxA measurements in images obtained from both ultrasound machines.

Results. 94% of transverse processes visualized in the Sonix Touch were also visible in the Telemed. The average difference per TxA measured with images obtained from the Telemed in comparison with the Sonix Touch was 3.0 ± 2.1°. Inter-observer error was also calculated from the mean range of all observer's TxA measurement per vertebrae in all subjects, and was 4.5° in the Telemed and 4.3° in the Sonix Touch. Results indicate the Telemed is able to offer equivalent visualization of skeletal landmarks that can be used in TxA measurement, which may be used to obtain spinal curvature measurements.

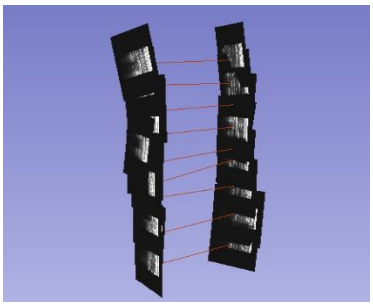

Fig. 1. Marked TxA-s of a full spinal column

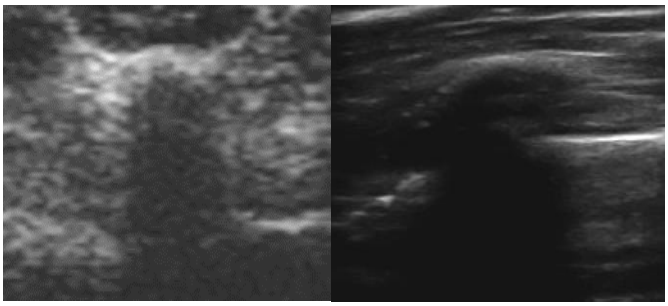

Fig. 2. Visualization of a single transverse process by the Telemed (left) and Sonix Touch (right)

Conclusion. Price and convenience suggest the Telemed to be a viable alternative for scoliosis monitoring. However, before implementing the Telemed in the clinical setting, a reduction in image noise is needed to further enhance landmark visibility. With improved image quality, the Telemed will be a suitable tool for safe and convenient scoliosis screening.

References. [1] Ungi *et al.* Ultrasound in medicine and biology 2(40), 447-454 (2014).