Clinical validation of manually registered ultrasound volumes of the shoulder

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Background, Motivation and Objective

In this project, an ultrasound-based protocol is proposed to acquire a tomographic ultrasound scan of all the bony structures in the rotator cuff region of the shoulder. Current clinical ultrasound imaging approaches possess a narrow field of view and require expert acquisition and interpretation. Solutions proposed in literature to mitigate these problems are either inaccurate or only work with other modalities, such as Magnetic Resonance Imaging (MRI). No literature discusses manual ultrasound image registration of the shoulder or attempted reconstructing a volume of the full region. It is believed that a clinically accurate full ultrasound volume reconstruction of the shoulder can drastically aid in the visualization of the region and pre-operative planning, simplify ultrasound interpretation and potentially be used in robotic surgeries.

Statement of Contribution/Methods

An accredited and licensed sonographer captured multiple sequential 3D images of a subject's inferior and superior shoulder both anteriorly and posteriorly by maintaining large overlays of bony anatomies between sequential volumes. The equipment employed was an ultrasound Philips VL13-5 curvilinear mechanically swept probe connected to an EPIQ 7 system. The acquired volumes were manually registered quadruple-wise using the ImFusion software, reconstructing the subject's entire rotator cuff region. The results were validated by overlaying the complete ultrasound volume and a corresponding shoulder MRI to determine whether the bony structures in both modalities align.

Preliminary Results/Discussion

An initial complete shoulder scan of a subject has been constructed. In addition to the scapula, humerus and clavicle bones, the sonographer was also able to clearly identify the acromioclavicular and glenohumeral joints; biceps, subscapularis and teres minor tendons; infraspinatus and supraspinatus muscles and the coracoacromial, coracohumeral and glenohumeral ligaments. Other structures were either partially perceived or not demonstrated at all. However, it is believed that an improved registration of the complete volume has the potential to demonstrate several more structures. The improvements will take place through revision of the manual registrations and the attachment of a robotic arm to the commercial probe during sonography to provide locational information of corresponding scanned volumes for a more efficient registration process.

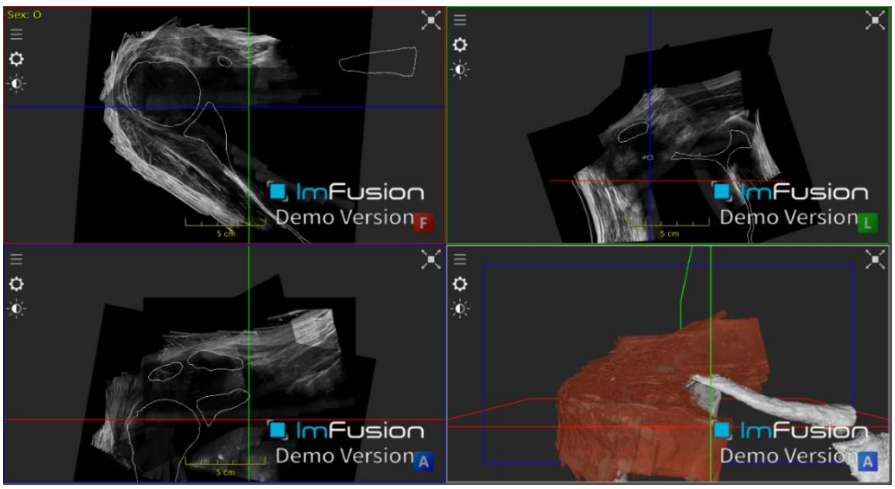

Figure 1: A complete, manually reconstructed 3D ultrasound volume of a subject's right shoulder overlaying a corresponding MRI