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Title: AI-Driven Automated Detection of Shoulder Rotator Cuff Tears using Ultrasound Imaging
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Background/Objective: The aim of this study is to investigate the application of an innovative AI tool in automatic detection of full-thickness rotator cuff tears (RCT) with ultrasound (US) and assess its potential to improve accessibility and expedite patient access to imaging by reducing experience required for image acquisition and streamlining treatment decisions. Currently, RCTs are primarily diagnosed through MRI, which is expensive, requires highly trained human operators and involves many months of wait time. Our user-friendly AI tool using US can be easily used by healthcare providers at the point of care to improve disease diagnosis and treatment planning. **Methods:** We propose a two-step explainable AI approach starting with segmentation then classification. Automatic segmentation of US scans is challenging due to speckle noise and low contrast. We utilized a CNN-autoencoder that predicts boundary contour points of humeral cortex and subacromial bursa directly from raw US images rather than the popular pixel-wise semantic segmentation. The original US image and the corresponding segmentation mask are then passed to a classification network (VGG-16) to determine whether tendons are torn or intact. This novel approach only passes the key portions of the scan (in which any tears are most visible) to the classification network, maximizing detection accuracy and clinical relevance. **Results and Discussion:** We evaluated this approach on data prospectively acquired from 210 patients, training with 11,600 images and testing with 2900 images. We had an average segmentation Dice coefficient (DC) of 95.3% and Hausdorff Distance (HD) of 2.9 mm, outperforming a U-Net model (DC=90.5%, HD=6.8 mm). The classification network, VGG-16, achieved 85.2% accuracy (sensitivity 84.2%, specificity 83.3%) in classifying supraspinatus tendons as intact or torn from US images. Results indicate that our AI-driven US evaluation pipeline has the potential to enable less-experienced ultrasound users to detect rotator cuff tears with high accuracy and explainability. **Conclusion:** Our combined approach of integrating segmentation and classification not only improves accuracy of AI detection of rotator cuff tears, but also enhances the explainability of results, creating a stronger trust in AI for clinicians and patients and potential to significantly impact the field of musculoskeletal diagnostic imaging.
References:
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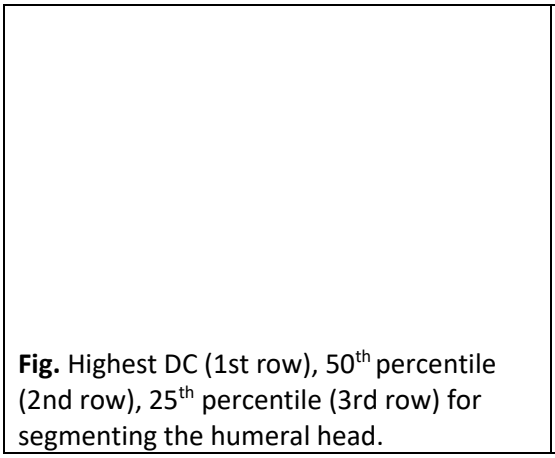

Fig. Highest DC (1st row), 50th percentile (2nd row), 25th percentile (3rd row) for segmenting the humeral head.

Segmentation	**DC(%)**	**HD(mm)**	
CNN+AE	**95.3±2.6**	**2.9±2.2**	
U-Net	90.5±5.6	6.8±4.8	
U-Net++	88.2±6.0	8.3±5.9	
Classification	**Accuracy**	**Sensitivity**	**Specificity**
VGG-16	**85.2**	**84.2**	**83.3**
InceptionV4	81.1	79.4	80.2
ResNet50	80.5	78.5	79.1

Table. Comparison of automated segmentation and classification results with expert manual (ground truth) values.