Magnetic Resonance Imaging (MRI) Augmented With Novel Artificial Intelligence System Is Equivalent To Computerized Tomography (CT) In Glenoid Imaging

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INTRODUCTION:

Glenoid bony morphology and measurement techniques have been the subject of multiple studies. Glenoid shape and the relevant bone loss that is often observed after a dislocation, affect the risk of recurrent dislocations. Several 2D and 3D methods have been described for measurement of glenoid bone loss, usually in the form of length or area of bone, relevant to the total width or area of the glenoid fossa. It has been widely accepted that computerized tomography (CT) is a superior imaging modality when compared to magnetic resonance imaging (MRI) in assessing the glenoid.

We compared CT images and MRI arthrogram images (T1 fat suppressed and VIBE MRI sequences), obtained from the same shoulder in patients presenting with anterior instability. We hypothesize that the CT images produced with manual segmentation and considered to be the gold standard in assessment of the bony glenoid, will be nearly identical to the MRI images that will be automatically produced with a custom deep learning platform that we have developed.

METHODS: An a prior power analysis for equivalence showed a required sample size of 24 patients per group.

We had two study cohorts.

In the first cohort we compared CT with T1 Fat suppressed MRI arthrograms and we included 78 scans (one CT and one MRI, in each of 39 patients).

In the second cohort we compared CT with T1 Volumetric interpolated breath-hold examination (VIBE) MRI arthrograms and we included 50 scans (one CT and one MRI, in each of 25 patients).

CT scan images were manually segmented using standard thresholding techniques with the 3D Slicer software. A custom artificial intelligence software platform that we developed, was used to create analogous segmentations from T1 fat-suppressed and T1 VIBE MRI arthrogram sequences.

A Dice Similarity Coefficient (DICE) score was chosen as the primary outcome measure to compare the CT and MRI arthrogram glenoid images that we generated. A second comparator of glenoid similarity was the mean squared error between the matched pairs of images. Measurements of the images of the four comparative groups were performed using programmatic techniques. We also compared the paired images for maximal glenoid width (max width), width of the glenoid at one third of the distance along the superior-inferior axis (upper width) and width of the glenoid at two thirds of the distance along the superior-inferior axis (lower width).

RESULTS:

DICE and mean square error when comparing matched glenoid images of CT vs T1 fat suppressed MRI indicated a near perfect accuracy of automatic segmentation of bone from MRI (DICE mean 0.961 and DICE standard deviation 0.013, mean square error 0.039 and standard deviation 0.017). The Spearman correlation coefficient between CT and T1 MRI demonstrated high correlation in all measured parameters (0.93 for max width/upper/lower width).

We demonstrated even higher similarity between CT and VIBE MRI, with favourable DICE and mean square error scores (DICE mean 0.965 and DICE standard deviation 0.008, mean square error 0.037 and standard deviation 0.009). The Spearman correlation coefficient between CT and VIBE MRI demonstrated high correlation in all measured parameters (0.98 for max width/upper/lower width).

DISCUSSION AND CONCLUSION:

Our study is the first in published literature to demonstrate excellent agreement in obtaining glenoid imaging between CT, which is considered to be the gold-standard modality, and MRI arthrograms in an automated way, through use of our custom software. Our platform's automated MRI-based reconstructions allow it to be used by any specialist, without any requirement for training in 3D image processing or analysis and such a method has not been described to our knowledge in the past. Our proposed method allows for measurements in a mathematically 'perfect' en-face view, which has been demonstrated to be important in allowing for appropriate measurements of bone loss, something that is difficult to achieve with previously described manual segmentation and measurement methods. With the additional benefit of MRI arthrograms allowing for diagnosis of soft tissue lesions, such as labral tears, and avoiding ionising radiation, we submit that in the future we could expect use of CT to be superseded by MRI arthrogram in glenoid imaging for anterior shoulder instability.