Assessing Liver Fibrosis: Comparison of Arterial Enhancement Fraction and Diffusion-Weighted Imaging

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TARGET AUDIENCE – Clinical researchers and radiologists

PURPOSE

Non-invasive markers, including imaging and serum biomarkers, have been developed over the past decade to reduce the need for liver biopsy. The aim of this study was to compare the ability of the Arterial Enhancement Fraction (AEF) and apparent diffusion coefficient (ADC) for assessing the degree of hepatic fibrosis, as confirmed histopathologically, in patients with chronic liver diseases (CLD).

METHODS

This HIPAA-compliant study included 85 patients with CLD who underwent abdominal, diffusion-weighted and contrast-enhanced MRI between January 2005 and December 2010. All studies were performed on a clinical 1.5-T MR imaging systems (GE Signa [GE Medical System, Waukesha, WI], or
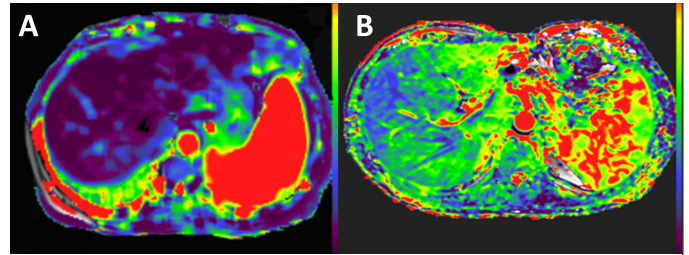

Figure 1: Arterial enhancement fraction (AEF) color map images of a patient with: A) No fibrosis on liver biopsy (mean hepatic AEF= 20.3%). B) Moderate fibrosis (mean hepatic AEF= 49.2%)

Siemens Magnetom Avanto [Siemens Healthcare, Erlangen, Germany]). Quantitative AEF color maps of the liver were generated from triple-phase contrast-enhanced MRI data. ROI-based analysis yielded mean AEF and ADC. Hepatic fibrosis was graded by histopathologic analysis according METAVIR criteria. The overall predictive ability of AEF, ADC, and a weighted composite score of AEF and ADC in assessment of fibrosis were compared using nonparametric tests and receiver operating characteristic (ROC) analysis, with histopathologic analysis as a reference standard.

RESULTS

AEF and ADC values differed significantly between fibrosis stages (Fig. 1). A significant positive linear correlation between AEF values and fibrosis stage (Spearman's rho = 0.65, $p<0.001$), and a significant negative correlation between ADC values and fibrosis stage (Spearman's rho = -0.54, $p<0.001$) were found. ROC analysis showed improved capability in discriminating fibrosis stages for AEF compared to ADC (Fig.2). The weighted composite score of AEF and ADC had a significantly higher diagnostic accuracy than ADC alone ($p\leq0.023$ for all comparisons). Furthermore, the composite score better discriminated cirrhosis (F4) from fibrosis ($F\leq3$) compared to AEF alone ($p=0.007$) and showed a trend for an improved ability to distinguish severe from mild fibrosis (F<3 vs. $F\geq3$, $p=0.059$).

DISCUSSION

In a recent comparison of MR elastography (MRE) and ADC [1], MRE outperformed ADC with a sensitivity and specificity of 72%, 91%, 92% and 95%, and 100%, 97%, 95% and 87% for prediction of fibrosis $\geq$F1, $\geq$F2, $\geq$F3 and F4, respectively. However, the use of MRE is currently limited by the cost of the required additional scanner hardware and limited availability of MRE imaging protocols and post-processing tools. In this study two commonly acquired MR sequences were utilized to determine the degree of hepatic fibrosis noninvasively. Additionally we found that while AEF outperformed ADC for the staging of fibrosis, a weighted composite score of AEF and ADC performed even better than the exclusive use of AEF or ADC alone. The advantage of combining AEF and ADC for assessment may be explained by assumption that the underlying mechanism of perfusion and diffusion contain independent information and are complementary. This is supported by a recent examination of intravoxel incoherent motion (IVIM) using low b-value MR diffusion imaging in liver fibrosis [2].

CONCLUSION

An accurate, reliable, reproducible, and noninvasive alternative for the detection and staging of fibrosis is essential in patients with CLD to determine the need for and response to therapy. This study showed that AEF can be used for the prediction of the presence of mild, moderate and advanced liver fibrosis, and its predictive value is increased with concomitant use of ADC in the form of a weighted composite score of AEF and ADC.

REFERENCES

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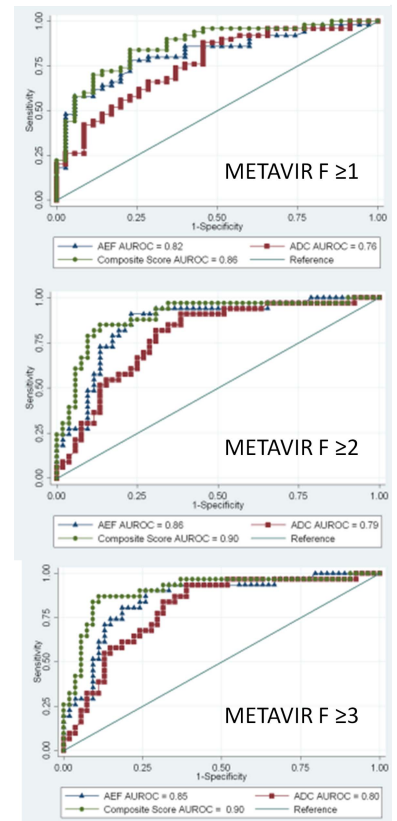
Figure 2: ROC curves comparing AEF (blue), ADC (red) and weighted composite score of AEF and ADC (green) for prediction of hepatic fibrosis.