# MR Elastography of Liver Tumors

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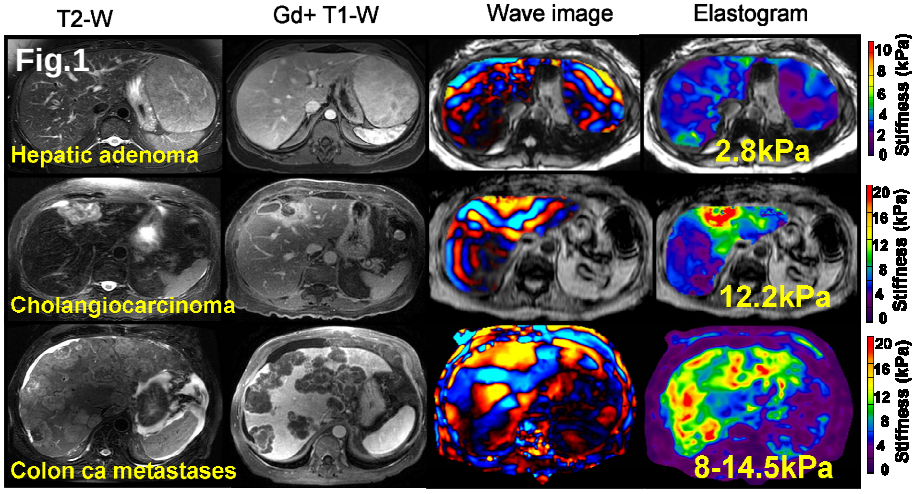
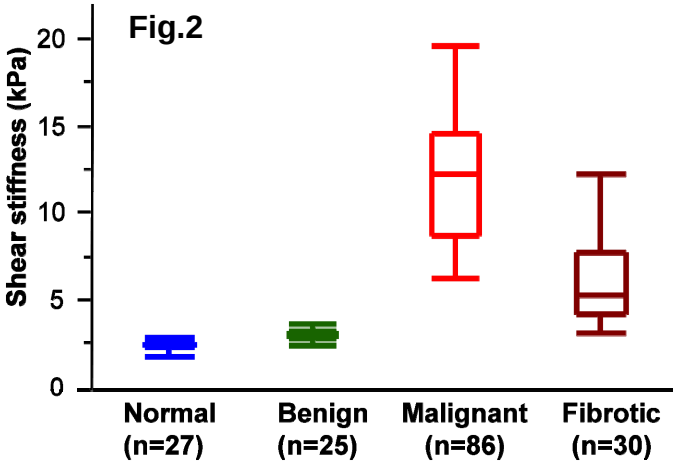
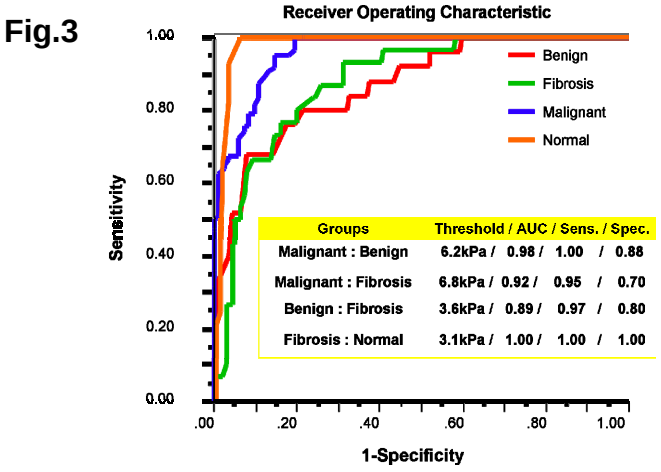
**Introduction:** Tumors are stiffer than normal tissues and frequently detected through physical palpation as a hard mass present within surrounding softer tissue [1]. This property of tumors on palpation is well known and used routinely by clinicians. However, palpation of tumors within the abdomen is difficult, except at surgery. Recently techniques such as magnetic resonance elastography (MRE) [2] has been developed which can non-invasively determine mechanical properties of liver. MRE has been shown to accurately estimate the degree of fibrosis in liver [3]. We evaluated MRE for its role in improving differentiation between benign and malignant tumors of liver in clinical patients.

**Materials and Methods:** MR Elastography was performed on 111 tumors in 57 patients. The tumors were metastases-47, hepatocellular carcinoma (HCC)-23, cholangiocarcinoma-14, hemangioma-14, focal nodular hyperplasia-6, hepatic adenoma-3, gall bladder carcinoma-1, and HCC-cholangiocarcinoma-1. Thirty patients had diffuse chronic liver disease and 27 patients had normal liver parenchyma. MRE was performed on a 1.5T or 3T clinical scanner with a modified gradient echo MRE sequence [3]. Stiffness maps were generated using local frequency estimation inversion algorithm [4]. Mean shear stiffness of the tumors and the surrounding non-tumor bearing liver parenchyma was measured using a manually specified region of interest. The tumors were group as benign or malignant based on the histopathology. Comparison of shear stiffness values between benign and malignant tumors was performed. The stiffness values were also compared with normal liver parenchyma and fibrotic liver. Shear stiffness values of individual tumor types were also calculated.

**Results:** Sufficient wave illumination of the tumors and the surrounding liver parenchyma was obtained, and MRE was technically successful in all of the patient studies (Fig.1). The mean stiffness ± SD values of normal liver, benign tumors, malignant tumors and fibrotic livers were 2.4kPa ± 0.3, 3.56kPa ± 1.9, 12.0kPa ± 3.5 and 6.1kPa ± 2.4 respectively (Fig.2). All malignant tumors had significantly higher shear stiffness than benign tumors ($p<0.001$), fibrotic liver ($p<0.01$) and normal liver ($p<0.001$). Fibrotic liver was significantly stiffer than benign tumors ($p<0.01$) and normal liver ($p<0.001$). The stiffness values of benign tumors did not significantly differ from normal liver parenchyma ($p=0.28$). ROC analysis estimated that malignant tumors could be differentiated from benign tumors with close to 100% sensitivity and 88% specificity with a threshold value of 6.2kPa (Fig.3). All benign tumors except 3 cases of complex hemangiomas showed shear stiffness value less than 5kPa. Among the primary tumors, cholangiocarcinomas had the highest stiffness values. The stiffness values of metastases were not significantly different from primary malignancies, but stiffer than the benign tumors.




**Conclusion:** MRE is feasible for technique for quantitatively evaluating mechanical properties of liver masses. MRE offers new parameters for tissue characterization with MRI. Results suggest that MRE is very promising for helping to differentiate malignant tumors from benign lesions. The technique is rapid and can be readily combined as a complement to conventional MRI studies of the abdomen to potentially improve characterization of liver tumors.

**References:**

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