DETECTION OF COLORECTAL LIVER METASTASES BY DIFFUSION-WEIGHTED IMAGING

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INTRODUCTION Diffusion weighted imaging (DWI) has the potential to detect and characterise hepatic lesions via quantitative differences in cellular architecture (1). Accurate identification and characterisation of hepatic metastases in patients with colorectal cancer is important for treatment planning. The aims of this study were to report the sensitivity and specificity of DWI techniques in detecting colorectal liver metastases compared to either a surgical gold standard or follow-up imaging (at 12-18 months that confirmed 20% increase in lesion diameter) and to establish whether quantitative DWI measurements can adequately characterise lesions.

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METHODS ***Patient Cohort:*** 33 patients (23 males and 10 females) aged 37-80 years (mean 63 ± 10 yrs) with hepatic metastases were recruited from those undergoing pre surgical work-up with Teslascan MRI. Imaging was performed on a 1.5 Tesla Intera (Philips Medical Systems, Best, Netherlands) using a body phased array surface coil to maximise signal to noise in the images. ***Imaging protocol:*** T1-W axial and coronal, and T2-W axial scans of the entire liver using single breath-hold were obtained. Coronal images assisted in the verification of lesion position according to the Couinaid segmental anatomy for surgical planning. Prior to injection of contrast agent, axial DW images were obtained through the liver using a single shot EPI DW sequence (b = 0, 150 and 500 sec/mm^2) with diffusion sensitizing gradients applied sequentially in three orthogonal directions. DW trace images were calculated for each b value. The entire liver was imaged in one or two 24 second breath holds as required for liver coverage, using a 7mm slice thickness with a slice gap of 1mm. Following the administration of a 20 minute infusion of the hepatocyte specific contrast agent Teslascan^{TM} (Amersham Healthcare) at a dose of 0.5ml/Kg body weight, T1-W coronal and axial series were acquired at 30 minutes and at 24 hours. ***Image Analysis:*** The DW and unenhanced T1/T2 weighted images were reviewed separately by two experienced radiologists blinded to histopathology and follow-up imaging. The size and location of all focal lesions were recorded on the b = 500 sec/mm^2 DWI trace images. Lesions were scored as **5 =** Definitely a metastasis (persistent high signal intensity at high b values (restricted diffusion)); **4 =** Probably a metastasis; **3 =** May or may not be a metastasis; **2 =** Probably not a metastasis; **1 =** Definitely not a metastasis (Benign). Image scores were compared to a gold standard of histopathology in 17 (51%) of the patient cohort and to follow up imaging in 16 (49%) of patients. Receiver Operator Characteristic (ROC) curves were generated for each reader to determine the sensitivity and specificity of DWI for detecting metastases compared to histopathology and follow up imaging. ADC values were obtained for normal appearing liver and liver lesions using DWI trace images for all b values to include perfusion and diffusion elements (ADC_{fast}), and excluding b=0 sec/mm^2 to exclude perfusion effects (ADC_{slow}).

RESULTS: 141 lesions were evaluated (5 of these were noted on histopathology only and missed on imaging). Mean lesion size 19.6mm (range 1-95mm) and mean number per patient 4.3 (range 1-15). On histopathology or follow-up imaging, 88 lesions were classified as metastases and 53 were classified benign (52 cysts and one haemangioma). 48/88 metastases (54%) and 16/53 (30%) benign lesions were confirmed on histology. 65% of metastases were located in the right lobe (segments V to VIII), and 35% in the left lobe (segments I to IV). For Reader 1, sensitivity of metastases detection was 69.9% (95% CI 58.8%- 79.5%) and specificity was 96.6% (95% CI 88.1%- 99.5%), area under the ROC curve 0.835. For Reader 2 sensitivity was 87.8% (95% CI 78.7%- 94.0%) and specificity 94.8% (95% CI 85.6%- 98.9%), area under the ROC curve 0.913. There was a significant improvement in the accuracy of metastases detection by Reader 2 compared to Reader 1 (p =0.029). For Reader 2, for the whole liver positive and negative predictive values were 79% and 78% respectively. For the left lobe of the liver alone positive and negative predictive values were 50% and 68% respectively.

	Mean ADC_{fast} (0-500)	Mean ADC_{slow} (150-500)
Metastases	1.94 ± 0.60	1.36 ± 0.52
Normal Liver	1.48 ± 0.22	1.04 ± 0.23
Cysts	3.95 ± .49	3.00 ± .55
Hemangioma (single lesion)	1.55 ± 0.27	1.29 ± 0.28

ADC X 10^{-3} mm^2/s

ADC values for lesions are given in the Table above. There was a significant difference between ADC values of cysts, metastases and normal liver for both the ADC_{fast} ($p<0.001$) and ADC_{slow} ($p<0.001$) results. There was also a significant difference in ADC values for normal liver ($p<0.001$) and metastasis ($p< 0.001$) when perfusion effects were included and excluded from the analysis.

CONCLUSION: The use of DWI has a good sensitivity and specificity for detection of colorectal cancer liver metastases. However, artefacts due to cardiac motion make DWI an inadequate diagnostic test for the left lobe of the liver. Quantitation of ADCs has utility in differentiating between benign cysts and metastases, but not between hemangiomas and metastases for the range of b-values used in this study.

References: Kim MJ et al JMRI 2004; 20 612-621. Besser for DWI methodology review articles