

# Diffusion-weighted imaging for the diagnosis of bland versus tumor thrombosis in the portal and renal veins.

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## Introduction

Distinguishing bland from tumor thrombus within the portal and renal veins has important implications for tumor staging, treatment and prognosis. There is limited evaluation of diffusion-weighted imaging (DWI) for the detection and diagnosis of venous thrombosis, particularly outside the central nervous system [1, 2]. Thrombus conspicuity is potentially enhanced by the application of diffusion gradients which suppresses blood motion [3]. Since DWI does not require contrast, it can be utilized in patients in whom Nephrogenic Systemic Fibrosis is a concern [4]. Furthermore, no studies have evaluated the ability to separate bland from tumor thrombus using DWI. Previous reports have shown that hepatocellular carcinoma (HCC), metastatic disease and renal cell carcinoma (RCC) demonstrate restricted diffusion [5, 6]. Thus we hypothesize that tumor thrombus will also demonstrate restricted diffusion and enable its detection.

## Methods

We retrospectively identified 20 patients (M=17, F=3, mean= 60.5 years) with portal or renal vein thrombosis diagnosed at MRI who received DWI as well as conventional contrast enhanced MRI at 1.5 T. Patients were evaluated at 1.5 T with axial SSEPI DWI using b= 0-50, 50-500 and 400-1000 sec/mm<sup>2</sup>, TR=1300-7584 ms/TE= 67-82 ms, slice thickness = 7-8 mm with breath hold, navigator or free-breathing techniques. Exclusion criteria were thrombus in sub-segmental portal veins or cavernous transformation because measurement of ADC and identifying clot would be difficult. Three blinded readers used DWI, fat suppressed T2 weighted spin echo, Half Fourier single shot fast spin echo and T1 weighted opposed phased imaging to detect and classify thrombus as bland or tumor. Tumor thrombus was diagnosed based on restricted diffusion. This was defined as signal intensity higher than the adjacent organ of interest (liver or kidney) with visually decreased ADC. ADC was also measured in each case. Diagnostic confidence was also recorded by each reader as follows: 1= not interpretable, 2= uncertain, 3= probable, 4= highly likely and 5= certain for either bland or tumor thrombus. The reference standard for diagnosing tumor thrombus was a consensus reading utilizing post contrast fat suppressed T1 weighted images in addition to the above described sequences, with reference to histology when available.

## Results

14 tumor thrombi and 6 bland thrombi were diagnosed at the reference standard (Fig.1). Bland thrombi were all in the main portal vein. The tumor thrombus subset included 13 reports of underlying HCCs and 1 report of RCC based on radiologist interpretations and correlative laboratory values. In terms of confidence scoring, reader 1 expressed high confidence only when assessing positive cases (p=0.0012) while reader 2 (p=0.385) and reader 3 (p=0.572) were equally confident for both the positive and negative cases. There was overall high sensitivity, specificity, PPV for prediction of tumor thrombus (Table 1). The diagnostic accuracy of readers 1, 2 and 3 was 0.86, 0.90 and 0.86 respectively, with a statistically significant association between each readers' interpretation and the reference standard. The mean ADC (x 10<sup>-3</sup> mm<sup>2</sup>/sec) for tumor thrombus was 1.16 ± 0.25, significantly lower than ADC of bland thrombus which was 1.71 ± 0.72 (p< 0.001).

	Reader 1	Reader 2	Reader 3	Overall
<b>Sens.</b>	0.93	0.87	0.80	0.87
<b>Spec.</b>	0.67	1.00	1.00	0.89
<b>PPV</b>	0.88	1.00	1.00	0.95
<b>NPV</b>	0.80	0.75	0.67	0.73
<b>P value</b>	0.011	<0.0001	0.0015	

Table 1. Performance of DWI for diagnosis of tumor thrombus

## Conclusion

Data on the utility of DWI in tumor thrombus in the abdomen is extremely limited. Our results demonstrate that restricted diffusion has high positive predictive value for tumor. Potential limitations of the study include variable signal intensity of thrombus based on chronicity, post-treatment effect on thrombus signal and the implications of underlying tumor volume/grade on pretest probability. These preliminary results demonstrate promise for the potential utility of DWI in detecting and predicting tumor thrombus both on a qualitative and quantitative basis.

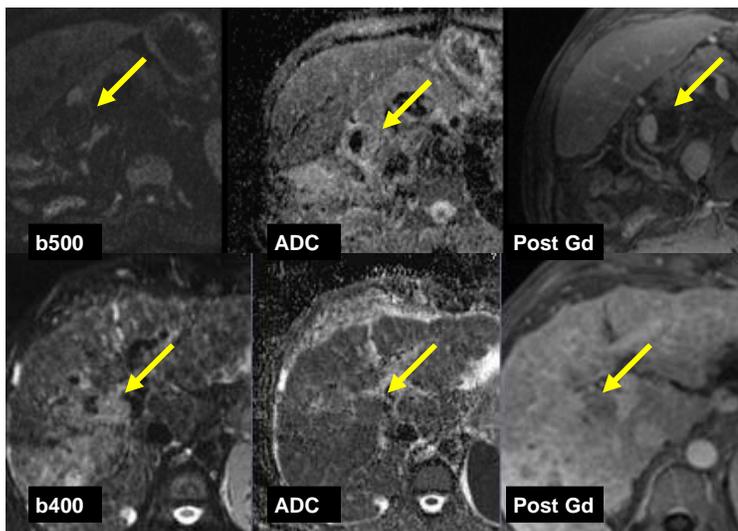


Fig 1. Top Row: Bland thrombus in the main portal vein demonstrates low signal on DWI for b=500 (left), high signal on ADC (middle) compatible with no restricted diffusion and no post-contrast enhancement (right).

Bottom Row: Tumor thrombus in the right portal vein demonstrates high signal on DWI for b=400 (left), low signal on ADC (middle) compatible with restricted diffusion and post-contrast enhancement (right).

## References

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