

HEPATOCELLULAR CARCINOMA (HCC) WITH PORTAL VENOUS TUMOR THROMBOSIS (PVTT) RESPONSE TO YTTRIUM-90 RADIOEMBOLIZATION EVALUATED BY FUNCTIONAL MRI

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Introduction:

Patients with hepatocellular carcinoma (HCC) and portal venous tumor thrombosis (PVTT) are not candidates for curative surgical resection; therefore liver-directed therapies would be alternative treatment, such as yttrium-90 (⁹⁰Y) radioembolization [1]. Earlier monitoring of advanced HCC response to treatment should influence the strategies of therapy. Moreover, detection of PVTT response to therapy is essential to predict survival rate as PVTT is one of the most important independent risk factors for higher recurrence rates and worse survival rates. However, changes in tumor cellularity and vascularity as initial responses to treatment are not compatible with the criteria of World Health Organization (WHO) and Response Evaluation Criteria in Solid Tumors (RECIST) which is based on anatomic images [2]. Contrast-enhanced magnetic resonance image (MRI) can detect changes in the extracellular space and tumor vascularity by percentage enhancement at arterial and portal venous phases imaging. Enhancement can be induced by viable tumor, whereas necrotic tumor is nonenhancing. Diffusion-weighted imaging (DWI) is a measure of water motion determined by cellularity and integrity of the cell membrane. Contrast-enhanced MRI and DWI identified as functional MRI have been proposed to demonstrate tumor cells response after regional liver treatment. Prior studies showed that an increase in apparent diffusion coefficient (ADC) values and a decrease in percentage enhancement indicate tumor response to treatment [3, 4]. The goal of this study was to evaluate the hypothesis that DWI can assess HCC and PVTT response to ⁹⁰Y radioembolization and compare DWI with contrast-enhanced MRI.

Material and methods:

Twenty-five consecutive patients (male 18, female 7; mean age: 62.4 years) with HCC and PVTT treated with ⁹⁰Y radioembolization without any prior treatment were included in this cohort. MRI studies were performed before (mean 12.8 days) and after (mean 31.2 days) ⁹⁰Y radioembolization. ADC values and percentage enhancement during the arterial and portal venous phases of tumor, PVTT and surrounding liver were calculated pre and post treatment. Gross pathological type, necrosis and hemorrhage as imaging features of tumor were recorded. Tumor and PVTT responses to treatment were evaluated on the basis of combined reference standards, including changes in tumor size, AFP, percentage of necrosis and follow-up. The repeated measures ANOVA was used to assess the effect of percentage change in ADC values and percentage enhancement to predict the treatment response according to combined criteria. Correlation coefficients assessed the relationship among tumor, thrombosis and liver.

Results:

According to the combined reference standard, 14 patients were partial responders to ⁹⁰Y radioembolization, 5 patients were non-responders, and 6 patients were stable disease cases. After ⁹⁰Y radioembolization, percentage change in tumor ADC values of partial responders was significantly higher than that of non-responders ($p < 0.05$), which increased 44.7% and decreased 30.7%, respectively. Percentage changes in HCC ADC values of stable diseases (13.8%) was not significantly lower than that of partial responders ($p > 0.05$) and was higher than that of non-responders ($p = 0.051$). For PVTT, percentage changes in ADC values of partial responders (36.6%) and stable diseases (32.2%) were significantly higher than that of non-responders (-15.1%, $p < 0.05$). There was no significant difference of percentage enhancement before and after treatment of cases which belong to partial responders, stable disease, and non-responders during arterial and portal venous phases ($p > 0.05$) 1 month after ⁹⁰Y radioembolization.

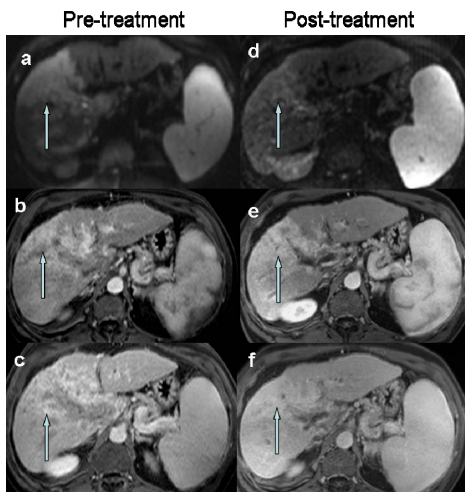


Figure 1 MR images of a 69-year-old male patient with cirrhosis and hepatocellular carcinoma (HCC) treated with ⁹⁰Y radioembolization. The tumor size was 140.1cm² before therapy and change in tumor size was 27.6% 1 month after treatment. HCC ADC value was $1.23 \times 10^{-3} \text{mm}^2/\text{s}$ (a) before treatment which increased to 2.46 at the same time (d) and PVTT ADC values also increased from 0.99 to 1.63. In contrast, HCC percentage enhancement in this case increased after radioembolization, which were 101.2% (b) and 98.7% (c) at arterial phase and portal venous phase before treatment and increased to 165.4% (e) and 187.6% (f) at 1 month. PVTT percentage enhancement increased from 20.9% and 80.0% to 40.6% and 102.8%, respectively. At 3 months follow-up MR images, this case was identified as partial responders according to the WHO criteria as tumor size decreased by 61.9%. Compared to percentage enhancement, HCC and PVTT response assessed by ADC values at 1 month preceded anatomic size changes.

Conclusion:

Based on significantly increased ADC values of HCC and PVTT, percentage change in ADC values could potentially be used to predict HCC and PVTT response 1 month after ⁹⁰Y radioembolization. ADC values were more specific to predict HCC and PVTT non-responders to ⁹⁰Y therapy at this time

point and cases of responders and stable disease cannot be distinguished by DWI. However, as one of functional imaging procedures, percentage enhancement at arterial and portal venous phases was not reliable predictor to assess advanced HCC with PVTT response 1 month after treatment.

References:

1. Kulik LM, et al. *Hepatology*, 2008. 47(1): p. 71-81.
2. Keppke AL, et al. *AJR Am J Roentgenol*. 2007. 188(3): p. 768-75.
3. Liapi E, et al. *AJR Am J Roentgenol*, 2008. 190(1): p. 67-73.
4. Vossen JA, et al. *J Comput Assist Tomogr*, 2008. 32(3): p. 347-52.