Dynamic Contrast-enhanced MRI in Evaluating the Intranodular Hemodynamic Characteristics of Focal Hepatic Nodules in an Experimental Rat Model

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INTRODUCTION

HCCs are the most common primary malignant tumors of the liver. Cirrhotic liver is often the background from which hepatocellular carcinomas (HCC) arise. Many HCCs develop through a progressive pathway from a benign regenerative nodules (RN) to a dysplastic nodules (DN) to a DN with microscopic foci of a HCC, and finally to the overt HCC in cirrhotic liver[1-2]. In addition, accompanying the malignant evolution of hepatic nodules is a gradual change in blood supply from portal to arterial[3-4]. Dynamic Contrast-enhanced MRI(DCE-MRI) has been used to assess hemodynamic changes in tumors such as HCCs, breast carcinomas for measuring enhancement-related parameters[5-6]. To our knowledge, DCE-MRI has no commonly be used to assess the blood supply of various cirrhotic nodules. The purpose of this study is to investigate the role of DCE-MRI in the evaluation of the intranodular hemodynamic characteristics of focal hepatic nodules in an experimental hepatocellular carcinoma (HCC) rat model.

METHODS

MR imaging was performed at 1.5 T MR scanner (Excite/HD, GE System), and a surface coil was used to receive MR signal. DCE-MRI was performed in 30 rats with chemically induced hepatocellular nodules ranging pathologically from RN to DN to HCC. RE-T (relative signal enhancement vs. time) curves of the nodules were obtained and classified into three patterns according to their shapes: Ⅰ (rapid wash-in and rapid wash-out), Ⅱ (rapid wash-in followed by a plateau), Ⅲ (slow increase in both arterial and portal phases). Time to peak (Tp), maximal relative signal enhancement (REmax), and the initial slope of signal intensity (Slope) vs. time curves of the nodules and adjacent cirrhotic liver were evaluated. Nodules precisely corresponding to MRI were examined histologically. Paired Sample`s t-tests were used to compare the difference between nodules and cirrhotic liver.

RESULTS

A total of 11 HCCs, 15 DNs, 6 RNs were evaluated. The REmax values of HCCs, DNs, RNs and adjacent cirrhotic liver were 265.18±232.00, 207.11±125.30, 259.8±71.19, 225.09±145.10 respectively. HCCs showed a significantly higher REmax ($t=2.818, P<0.05$), shorter Tp ($t=-4.519, P<0.05$), and higher Slope ($t=4.121, P<0.05$) than cirrhotic liver. The REmax of DNs were significantly lower than cirrhotic liver ($t=-2.167, P<0.05$). Although the Tp of DNs was delayed two seconds compared to cirrhotic liver, there was no significant difference between them($t=0.959, P>0.05$). No significant difference of dynamic enhancement parameters was found between RNs and hepatic parenchyma ($P>0.05$).

Pattern ⅠRE-T curves were most commonly seen in well-differentiated HCCs. However DNs showed pattern Ⅱand Ⅲ curves with a lower REmax compared to the adjacent liver.The curve pattern of RNs almost consistent with the adjacent liver parenchyma.

DISCUSSION AND CONCLUSION

Blood supply to the various nodules in cirrhotic liver is complex. During the development of hepatocarcinogenesis, the intranodular portal supply tends to decrease and the arterial supply tends to increase[3-4]. Recent histopathologic and immunohistochemical studies showed that the degree of capillarization of sinusoids and the number of unpaired arteries are related to the gradual change in blood supply from portal the arterial, as a DN becomes an HCC.

Our results show that the Maximal enhancement of HCCs was found during the arterial phase, when the REmax and the initial slope of the RE-T curve were significantly higher than adjacent cirrhotic liver. This results indicates that HCCs present increased blood supply and were predominantly supplied by hepatic arteries. In contrast, a few of DNs (3 HGDN and 1 LGDN) had the same blood supply as the adjacent cirrhotic liver, which may suggest that preexisting hepatic arteries and portal veins have not yet decreased, this kind of DNs would have the same blood supply as the adjacent cirrhotic liver. Most of DNs (6 HGDN and 5 LGDN) in our studies were all hypovascular, which may suggests that preexisting hepatic arteries and portal vein have decreased in association with the insufficient developed neoangiogenesis. Because RNs consist of hepatocytes with no basis of cytological and architectural atypia, their blood supply were similar to cirrhotic liver.

In conclusion, DCE-MRI can potentially provide information about the intranodular hemodynamic characteristics of hepatic nodules in an experimental rat model. HCCs were markedly hypervascular compared to cirrhotic liver, while DNs were probably hypo- or isovascular.

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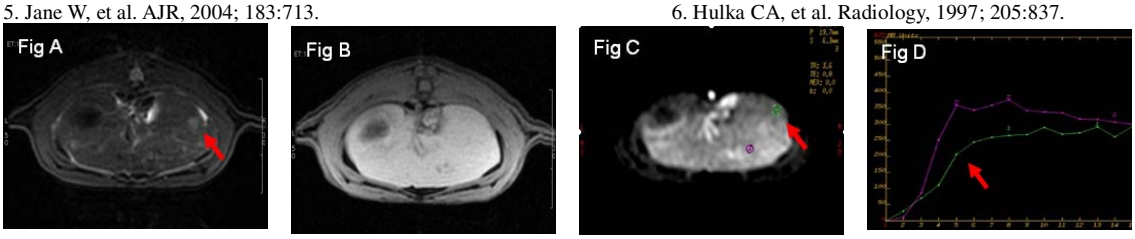

Fig 1. HGDN. The lesion (red arrow) showed mildly hyperintense on fat saturated T2WI (Fig A) and isointense on T1WI (Fig B), DCE-MR images of the DN and adjacent cirrhotic liver (Fig C) and RE-T curves of the DN and adjacent cirrhotic liver (Fig D). The curve of DN (green line) shows a pattern like rapid wash-in followed by a plateau, and the REmax of DN was significantly lower than that of adjacent cirrhotic liver.

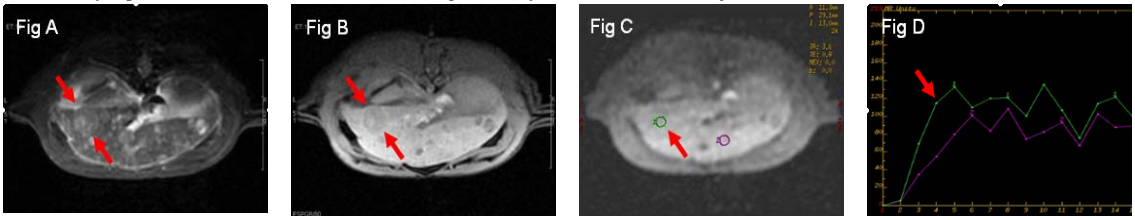

Fig 2. Well-differentiated HCC. The lesion (red arrow) showed heterogeneous hyperintense on fat saturated T2WI (Fig A) and heterogeneous hypointense on T1WI (Fig B), DCE-MR images of the HCC and adjacent cirrhotic liver (Fig C) and RE-T curves of the HCC and adjacent cirrhotic liver (Fig D). The curve of HCC (green line) shows a pattern like rapid wash-in and rapid wash-out, which indicates that HCC presents increased blood supply and were predominantly supplied by hepatic arteries.