Magnetic Resonance Imaging characteristics of Hepatocellular carcinoma after High-intensity focused ultrasound ablation

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Purpose:

High-intensity focused ultrasound ablation (HIFU) is a noninvasive technique for local thermal ablation of hepatocellular carcinoma (HCC). The interpretation of radiographic findings in HCC treated with HIFU is critical for assessing treatment adequacy. MRI is alternatively used for patients with hepatic tumors because it is not satisfactory to evaluate the lipiodol laden masses on CT scan. Tissue changes following HIFU treatment begin with appearance of homogeneous coagulative necrosis. The subsequent inflammatory response includes formation of granulation tissue at the periphery of the necrotic region after 7 days. Two weeks following HIFU treatment, the periphery of the treated region is replaced by proliferative repair tissue. We reviewed our experience and report the unique MRI characteristics of HIFU-treated HCC.

Materials and Methods

From January 2006 to September 2006, total 54 tumors of 34 patients (27 men and 7 women, aged 44-71 years) with hepatocellular carcinoma treated by HIFU were included. Therapeutic high-intensity focused ultrasound system (Chongqing Haifu HIFU; Chongqing Haifu, Chongqing, China) was used for HIFU treatment under the guidance of real-time ultrasound (3.5-5.0 MHz diagnostic US probe). Follow-up MRI was obtained, 2 weeks in all patients, 3 months in 20 patients, and 6 months in 5 patients after ablation. We used two1.5 T units (Magnetom Vision Plus or Signa Excite) with phase array body coil. Unenhanced MR images included FSE T2WI Axial dual echo FSPGR or in & out of phase 2D FLASH T1WI. Dynamic multiphase study was obtained on 15 sec, 45 sec and 90 sec after gadolinium administration. Three planes of delayed contrast enhanced T1WI were obtained.

Thermal ablation zone size was analyzed. We divided the signal intensity of ablated tumor into 3 types both on T1 and T2WIs (Type 1; homogeneous high signal intensity with low signal rim, type 2; heterogeneous high signal intensity and type 3; low signal intensity on T1WI and type1; homogeneous low signal intensity, type 2; heterogeneous low signal intensity and type 3, heterogeneous high signal intensity on T2WI). Enhancement pattern were also evaluated. Treatment efficacy and complications were assessed at each time.

Results:

The mean tumor size at ablation was 3.4cm, with minimal reduction over time. On initial postablation MRI, ablated lesions were characterized by high signal intensity with variable extent of heterogeneity on T1WI, heterogeneous low signal intensity on T2WI and peripheral rim enhancement. Incomplete ablation showed high signal intensity on T2WI. Seventeen tumors showed nodular enhancement on early arterial phase, indicating incomplete ablation. During follow-up period, the peripheral rim enhancement was diminished and lesion size was decreased in completely ablated tumor. Three tumors were recurrent during follow-up period, showing typical enhancement pattern of HCC. One of lesion with nodular enhancement showed complete regression of the enhancement. All patients showed ablation of the subcutaneous fat and pericostal muscles along the ultrasound port.

Conclusions:

The MRI characteristics of successfully ablated HCC after HIFU include high signal intensity on T1-weighted image and low signal intensity on T2-weighted image with peripheral rim enhancement. Ablated areas may develop areas of heterogeneous signal intensity both on T1 and T2-weighted images, but, nodular enhancing tissue in the region of the ablation zone should raise concern of incomplete ablation or tumor recurrence.

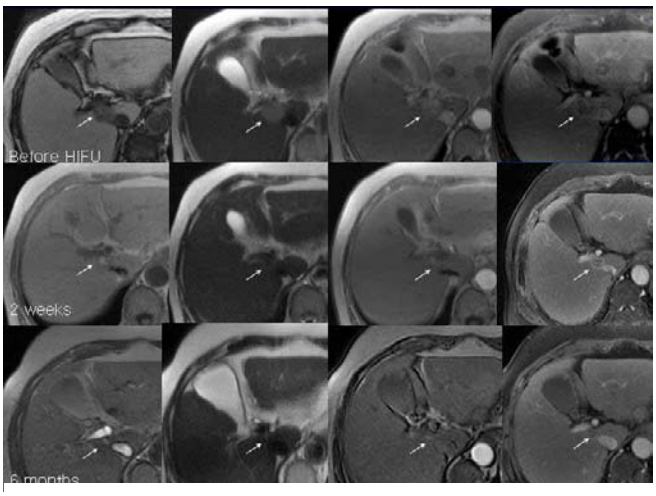

Fig. A 47-year old woman with HCC at the segment 6 of the liver. On FU MRI 2 weeks after HIFU, the tumor is decreased in size with high signal intensity on T1WI and low signal intensity on T2WI with peripheral rim enhancement. FU MRI 6 months after HIFU, the tumor is contracted with peripheral rim enhancement.

Table. Signal intensity pattern of the ablated tumors in complete and incomplete ablation

Complete ablation						Incomplete ablation					
SI pattern		T2WI				SI pattern		T2WI			
		1	2	3				1	2	3	
T1WI	1	8	5	6	19	T1WI	1	0	0	2	2
	2	5	7	4	16		2	0	2	8	10
	3	0	1	0	1		3	0	2	4	6
Total		13	13	10	36	Total		0	4	14	18

References: Kennedy JE. High-intensity focused ultrasound in the treatment of solid tumours. Nature reviews cancer 2005;5:321-327