Fusion Image of Gd-EOB-DTPA MRI and Ultrasound Guiding Microwave Ablation of Hepatocellular Carcinoma Adjacent to Intrahepatic Bile Ducts: A Report of Two Cases

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Abstract: Ultrasound (US) has been the most common imaging modality to guide ablation therapy. However, if the tumor is adjacent to intrahepatic bile ducts, only using US as guiding image may not be safe or effective. Gd-EOB-DTPA magnetic resonance imaging (MRI) enables improved liver lesion detection as well as a better illustration of the biliary system information [1-3]. We report two cases of microwave ablation (MWA) guided by a real-time image fusion of Gd-EOB-DTPA MRI and US for hepatocellular carcinoma (HCC) located adjacent to the intrahepatic bile ducts. The therapeutic effect was assessed by contrast enhanced ultrasound (CEUS) and MRI.

Key words: Liver neoplasms; Microwave ablation; Image fusion; Magnetic resonance imaging

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Case 1

In 2016, a 49-year-old male patient with weakness and discomfort in right upper abdomen entered our hospital for further examination. He had a history of hepatitis B virus cirrhosis for 1 year, and received two MWAs for HCC last year (tumors located in S8, S4, S6 separately). Liver function: Child-pugh B. Tumor marker: AFP 363.9 ng/mL. Gd-EOB-DTPA MRI showed 2 new HCC lesions in the liver, one tumor located in S4 (Fig. 1A), sized 1.2cm, and the other located in S8, 5mm away from right bile duct (Fig. 1C), sized 2.4cm. According to multidisciplinary consultation, HCCs were located in the left and the right liver, unsuitable for surgery, and MWA or transcatheter arterial chemoembolization (TACE) was recommended. The patient and his families refused TACE and required MWA terminal therapy.

Case 2

In 2016, a 56-year-old male patient with hepatitis B virus cirrhosis for 5 years entered our hospital for follow-up. He had undergone hepatic carcinectomy and transcatheter arterial chemoembolization for HCC 2 years ago. His elder brother died of liver cancer as well. Gd-EOB-DTPA MRI (Fig. 2A) and CEUS (Fig. 2B) showed a new HCC lesion in the left liver, sized 1.6cm. The distance of the tumor and left hepatic duct was 6mm in CEUS. Liver function: Child-pugh A. AFP was normal. Considering that the tumor was small and liver function mainly depended on the left liver, hepatectomy could have great impact on postoperative liver function, so multidisciplinary consultation was recommended MWA for this lesion.

For the two cases, preoperative Gd-EOB-DTPA MRI and CEUS had both showed HCC recurrence. Written

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informed consent was obtained from the patients included in the study. The process of image fusion was as follows: Prior to MWA, Gd-EOB-DTPA MRI data was transferred in DICOM format to the US system. Hepatobiliary phase MRI images clearly showed both the index tumor and the surrounding bile ducts. Plane registration was performed. Once registration was finalized, the system simultaneously displayed real-time US scans on one side of the screen and MRI reconstructed scans on the other side. Then the relationship between the index tumor and the bile duct was assessed in three dimensional spaces. MWAs were performed under intravenous anesthesia. During insertion of the electrode (Fig. 2D), and throughout the ablation procedure (Fig. 1C), the anatomical relationship between the ablation electrode and the intrahepatic bile duct in three dimensions can be clearly displayed on the screen. CEUS within 2 days (Fig. 1B, Fig. 1D and Fig. 2C) and contrast enhanced MRI at 2 months (Fig. 2E) after MWAs confirmed complete ablation of the two cases. No complications occurred in these two cases.

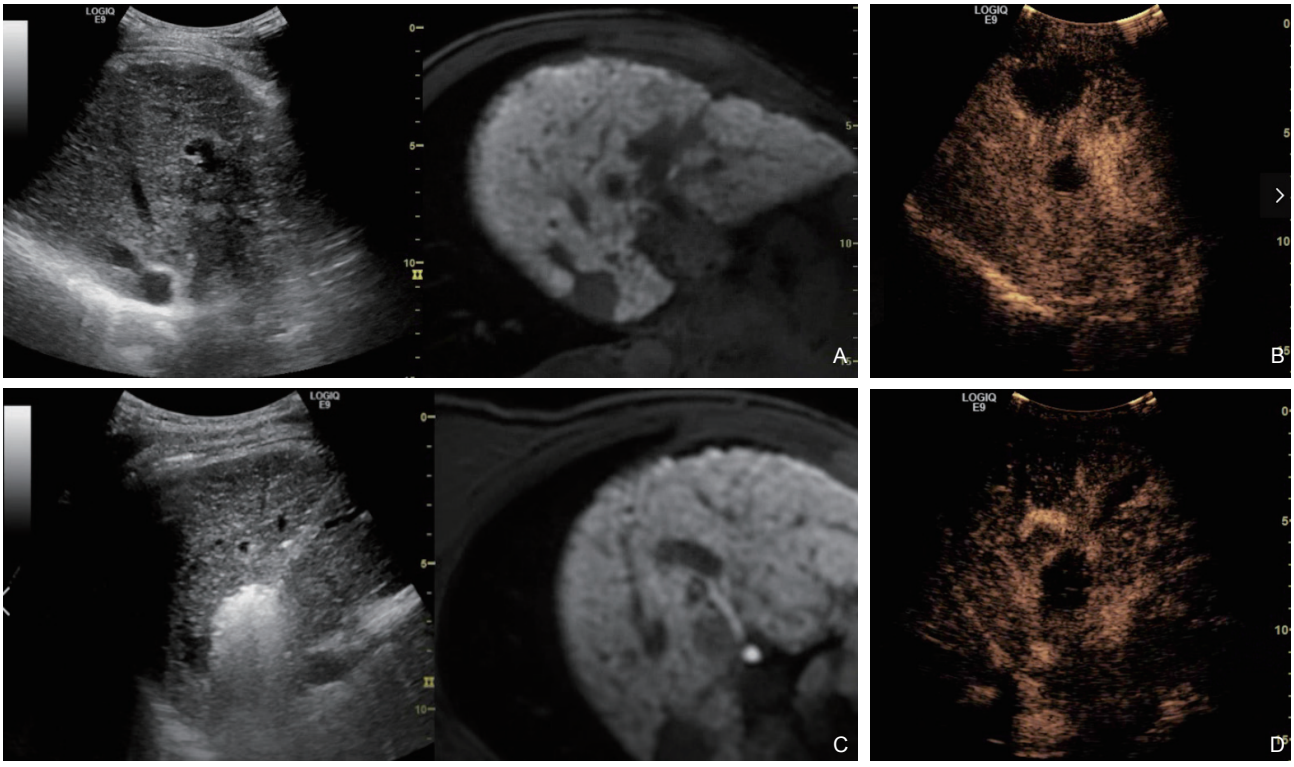

Figure 1 MWA of case 1. (A) MRI-US image fusion showed one tumor located in left liver. Figure (C) MRI-US image fusion showed the other tumor located in right liver adjacent to intrahepatic bile duct, the ablation electrode, the tumor and right bile duct can be clearly displayed on the screen during MWA; (B) and (D) Postoperative CEUS showed complete ablation of the 2 lesions.

Conclusion

The fusion image of Gd-EOB-DTPA MRI and US could be a safe, feasible and effective technique for guiding MWA of HCC, and may provide a new way for the treatment of liver neoplasms adjacent to intrahepatic bile ducts, thus help operators improve the complete ablation rate in the first session.

Discussion

MWA has been widely used in clinical practice and shown to be a promising technique for treatment of HCC [4-7], with accumulation of cases and technical progress, the prevention of MWA complications has been stressed. The incidence of biliary tract complications (such as cholangitis, bile leakage and biliary peritonitis) is low, but the consequences may be serious. It has been reported a new bile duct cooling protection technique can effectively protect intrahepatic biliary ducts from the thermal damage caused by microwave heat [8], thus in clinical practice the indication scope of MWA is greatly expanded. The short-term therapeutic effect is satisfactory, nevertheless, further study is required to investigate its long-term therapeutic effect.

Treatment of HCC should be optimized for individual patients according to the tumor location and size and to the patient's hepatic reserve. Choosing the right image modality is essential for guiding MWA. Ultrasound is most commonly employed as it has no radiation, high image resolution, and allows real-time depiction of the

entire treatment process. CT and MRI guidance can be useful for the treatment of HCC that is invisible on ultrasound [9-10]. In this report, we clearly demonstrated Gd-EOB-DTPA MRI and US image fusion is beneficial to the procedure of MWA for HCC located near intrahepatic bile ducts and help operators improve the complete ablation rate in the first session.

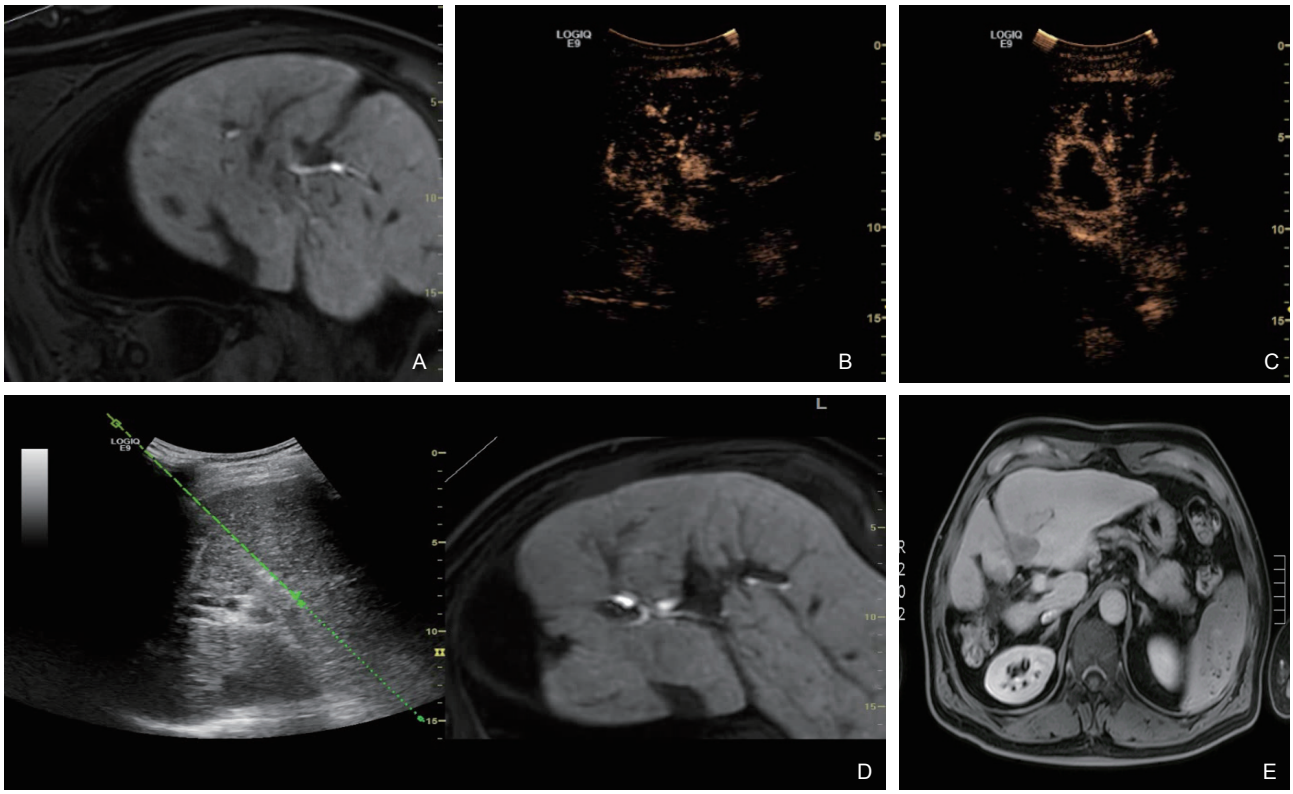

Figure 2 MWA of case 2. (A) Hepatobiliary phase image of GD-EOB-DTPA MRI showed both HCC and the surrounding bile duct were clearly; (B) Preoperative CEUS showed significantly enhanced of HCC; (C) Postoperative CEUS showed complete ablation of HCC; (D) MRI-US image fusion showed HCC was located in the left liver adjacent to left bile duct, the ablation electrode, the tumor and right bile duct can be clearly displayed on the screen during insertion of the electrode; (E) Postoperative MRI 2 months after MWA confirmed complete necrosis of HCC.

Despite encouraging experimental and clinical results, MWA, like other ablation techniques, is still in its evolutionary infancy [11]. Simultaneous application of multiple antennae used in clinical practice results in effective large tumor control and more uniform coagulation, which may expand the indications of MWA [12-13]. Liang's group first tried to achieve precision MWA in liver tumors by using multimodal imaging fusion navigation and a computer-assisted three-dimensional (3D) visualization ablation planning system which was invented by their group [14-17]. MWA is a very promising minimally invasive technique for treating malignant hepatic tumors, and we predict that using multiple applicators to achieve larger tumor coagulation volumes, and combining with multiple imaging modes would contribute to its safer use, more feasible application and will replace most hepatic resections in the near future.

This study had some limitations. First, the data only involved a few cases, has a short follow-up time and does not contain a comparison with other therapies. It may also need to be further confirmed whether it can be used in radiofrequency ablation or not. Second, this study was our experience with microwave ablation by whom with much experience. Therefore, there was lower local tumor progression. To conclude, although US-MRI image fusion is precise for targeting and achieving successful ablation of target tumors, the conclusions require elucidation by a multicenter randomized controlled study.

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Conflict Of Interest

The authors have declared no conflicts of interest. The funders had no role in study design, data collection and analysis, decision to publication, or preparation of the paper.

References

[1] Kudo M. Will Gd-EOB-MRI change the diagnostic algorithm in hepatocellular carcinoma? *Oncology* 2010;78 Suppl 1:87-93.

[2] Huppertz A, Balzer T, Blakeborough A, Breuer J, Giovagnoni A, Heinz-Peer G, et al. Improved detection of focal liver lesions at MR imaging: multicenter comparison of gadoxetic acid-enhanced MR images with intraoperative findings. *Radiology* 2004;230:266-75.

[3] Iannicelli E, Di Pietropaolo M, Marignani M, Briani C, Federici GF, Delle Fave G, et al. Gadoxetic acid-enhanced MRI for hepatocellular carcinoma and hypointense nodule observed in the hepatobiliary phase. *Radiol Med*. 2014;119:367-76.

[4] Liang P, Wang Y. Microwave ablation of hepatocellular carcinoma. *Oncology* 2007;72 Suppl 1:124-31.

[5] Liang P, Wang Y, Yu X, Dong B. Malignant liver tumors: treatment with percutaneous microwave ablation--complications among cohort of 1136 patients. *Radiology* 2009;251:933-40.

[6] Zhang X, Chen B, Hu S, Wang L, Wang K, Wachtel MS, et al. Microwave ablation with cooled-tip electrode for liver cancer: an analysis of 160 cases. *Hepatogastroenterology* 2008;55:2184-7.

[7] Lu MD, Chen JW, Xie XY, Liu L, Huang XQ, Liang LJ, et al. Hepatocellular carcinoma: US-guided percutaneous microwave coagulation therapy. *Radiology*. 2001;221:167-72.

[8] Shimada S, Hirota M, Beppu T, Matsuda T, Hayashi N, Tashima S, et al. Complications and management of microwave coagulation therapy for primary and metastatic liver tumors. *Surg Today* 1998;28:1130-7.

[9] Sato M, Watanabe Y, Tokui K, Kawachi K, Sugata S, Ikezoe J. CT-guided treatment of ultrasonically invisible hepatocellular carcinoma. *Am J Gastroenterol* 2000;95:2102-6.

[10] Hoffmann R, Rempp H, Keßler DE, Weiß J, Pereira PL, Nikolaou K, et al. MR-guided microwave ablation in hepatic tumours: initial results in clinical routine. *Eur Radiol* 2017;27:1467-6.

[11] Dodd GD 3rd, Soulen MC, Kane RA, Livraghi T, Lees WR, Yamashita Y, et al. Minimally invasive treatment of malignant hepatic tumors: at the threshold of a major breakthrough. *Radiographics* 2000;20:9-27.

[12] Simon CJ, Dupuy DE, Iannitti DA, Lu DS, Yu NC, Aswad BI, et al. Intraoperative triple antenna hepatic microwave ablation. *AJR Am J Roentgenol* 2006;187:W333-40.

[13] Wright AS, Lee FT, Jr., Mahvi DM. Hepatic microwave ablation with multiple antennae results in synergistically larger zones of coagulation necrosis. *Ann Surg Oncol* 2003;10:275-83.

[14] Liu F, Yu X, Liang P, Cheng Z, Han Z, Dong B. Contrast-enhanced ultrasound-guided microwave ablation for hepatocellular carcinoma inconspicuous on conventional ultrasound. *Int J Hyperthermia* 2011;27:555-62.

[15] Liu FY, Yu XL, Liang P, Cheng ZG, Han ZY, Dong BW, et al. Microwave ablation assisted by a real-time virtual navigation system for hepatocellular carcinoma undetectable by conventional ultrasonography. *Eur J Radiol* 2012;81:1455-9.

[16] Yu X, Liu F, Liang P, Era AD, Cheng Z, Han Z. Microwave ablation assisted by a computerised tomography-ultrasonography fusion imaging system for liver lesions: an ex vivo experimental study. *Int J Hyperthermia* 2011;27:172-9.

[17] Liu F, Liang P, Yu X, Lu T, Cheng Z, Lei C, et al. A three-dimensional visualisation preoperative treatment planning system in microwave ablation for liver cancer: a preliminary clinical application. *Int J Hyperthermia* 2013;29:671-7.