MR Imaging Findings of Osteosarcomas Treated with High Intensity Focused Ultrasound: Preliminary Results

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PURPOSE: To describe the MR imaging findings of osteosarcomas treated with high intensity focused ultrasound (HIFU) and evaluate prospectively the value of HIFU in ablation of those tumors. **METHODS:** The images of nonenhanced and multiphase gadolinium-enhanced MR imaging before and after HIFU treatment in six patients with osteosarcomas pathologically confirmed were interpreted prospectively in a blinded fashion. **RESULTS:** Blood supply of all tumor region decreased significantly and the tumor size reduced gradually after HIFU treatment. Pathologic findings revealed that the tumor showed irreversible coagulative necrosis. **CONCLUSION:** HIFU is an effective local therapy for osteosarcomas.

Introduction

Ultrasound (US) can be transmitted through solid tissue of the body and focused within the selective tissue, so this allows the feasibility of using an external source of US to destroy the in-depth tumor without surgery or insertion of instruments. High intensity focused ultrasound (HIFU) is a noninvasive extracorporeal technique. In the past few years, a lot of animal experiments and clinical trials have been performed and proved that HIFU produced target ablation of tumors in liver, kidney, bladder, brain and prostate. However, to our knowledge, few clinical trials that used extracorporeal HIFU in ablation of osteosarcomas have been reported in the English literature. The purpose of this study was to describe the MR imaging findings of osteosarcomas treated with HIFU, and evaluate the efficacy of HIFU in ablation of those tumors.

Methods

The HIFU therapeutic system was designed by Chongqing Hifu Co.Ltd (Chongqing, China) and the transducer were mounted in a water bag with its beams pointed upward. HIFU treatment was performed under spinal anesthesia with the patient lying in the prone or supine position and the tumor overlaying skin easily in contact with degassed water. Under the real-time monitoring of diagnostic US, complete coverage of the whole tumor volume was achieved through the tumor ablation slice-by-slice.

From December 1999 to November 2001, a total of 168 patients under-went extracorporeal HIFU ablation of tumors at department of ultrasound, PLA 307 hospital. Only six patients (4 men and 2 women, aged 13~46 years, mean 24 years) with pathologicallly proved osteosarcomas have been performed examinations at 1.5T GE MR system before HIFU 1 to 5 weeks at our department. After HIFU treatment 2 to 4 weeks, 2 to 3 months, 6 months and 1 year, MR scanning performed again. The sequence protocol included SE T1WI, FSE T2WI with fat saturation, and multiphase gadolinium-enhanced MR imaging (Fast multiplanar spoiled gradient-recalled imaging, 14 slices within 18~23sec, power injector 1.5~3.0ml/sec, scan delay time 18~25sec, coronal, sagittal and axial scanning performed, and scan interval 5~10sec. Delay scan: SE T1WI with fat saturation). The images of nonenhanced and multiphase gadolinium-enhanced MR imaging before and after HIFU treatment in six patients with osteosarcomas pathologically confirmed were interpreted prospectively in a blinded fashion.

Results and Discussion

Before HIFU treatment, six osteosarcomas were heterogeneously hypointense on T1WI and hyperintense on T2WI, slight or moderate enhancement on capillary phase, and moderate or strong enhancement on delayed phase and showed abnormal radioactivity accumulation. After HIFU 2 to 4 weeks, 2 to 3 months, 6 months and 1 year, all osteosarcomas were heterogeneously hypointense on T1WI, hyperintense on T2WI, and no enhancement on capillary and delayed phase, and the tumor size reduced gradually and abnormal radioactivity accumulation of the tumors disappeared. Pathologic findings of US-guided biopsy revealed that the tumor showed irreversible coagulative necrosis. After HIFU 6 month, a small nodule within one osteosarcoma showed moderate enhancement on capillary phase and strong enhancement on delayed phase and appeared abnormal radioactivity accumulation.

It is generally believed that US propagation through the bone is almost impossible in the diagnosis and treatment of bone disease. However, recent transcranial US technique imply that US beams can be transmitted through bones and the substantial attenuation of ultrasonic power can be compensated by focusing, and the beam distortion could be eliminated by using phase correction. In this study, we found focused US can penetrate through osteosarcomas and cause complete coagulative necrosis of the tumors. A series of MR imaging findings of osteosarcomas treated with extracorporeal HIFU revealed that blood supply of all tumor region decreased significantly and the tumor size reduced gradually, which indicated that the tumors was ablated completely, and the results correlated well with radionuclide bone scanning.

Conclusion

HIFU is an effective local therapy for osteosarcomas.

References

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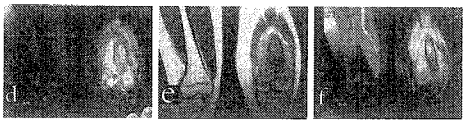
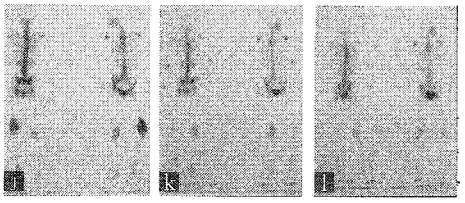
Fig 1. A-14-year old female with pathologically proved osteosarcoma of left femur. (a)T2WI, (b) T1WI, (c) Gd-DTPA delayed phase. Apri-10-2001, after chemotherapy and before HIFU one week, the MR imaging findings of the tumor showed hypervascular (alive).



(d) T2WI, (e) T1WI, (f) Gd-DTPA delayed phase. May-22-2001, after HIFU treatment three weeks, the MR imaging findings revealed that blood supply of the tumor disappeared (ablated) and the tumor size reduced slightly.

(g) T2WI, (h) T1WI, (i) Gd-DTPA delayed phase. Oct-23-2001, after HIFU treatment six month, the MR imaging findings revealed that blood supply of the tumor disappeared (ablated) and the tumor size reduced.



(j) Mar-20-2001 bone scanning, after chemotherapy before HIFU therapy four weeks, abnormal radioactivity detected. (k) May-25-2001 bone scanning, after HIFU therapy five weeks, abnormal radioactivity disappeared. (l) Oct-16-2001 bone scanning, after HIFU therapy six month, abnormal radioactivity disappeared.