High Intensity Focused Ultrasound (HIFU) in the Treatment of Hepatic Malignancy

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HIFU Treatment for Hepatic Malignancy

Noninvasive, image-guided tumour treatment with high-intensity focused ultrasound (HIFU) is receiving increasing interest as a promising modality in the treatment of solid malignancies. An ultrasound beam can be focused and transmitted through solid tissues. This ability allows the possibility of using an extracorporeal source of ultrasound for therapeutic purpose. If sufficient acoustic energy is concentrated within the focal volume, the temperature in that region may be raised to levels at which the tumours are cooked, resulting in coagulation necrosis. Compared to the minimally invasive modalities, HIFU is a truly noninvasive therapy, without damaging overlying and surrounding vital structures. The thermal ablation provides a potential therapy for destroying entire tumours in a 3-dimension conformal fashion, and it is expected to be very precise and complete with almost no limitation of tumour size and shape. As a result, these advantages make it one of the most attractive potential therapies for the localized treatment of tumour in the future.

This article will introduce our clinical experiences of using ultrasound-guided HIFU in the treatment of patients with hepatic malignancy in both China and England. Same HIFU therapeutic system (Chongqing Haifu Tech Co., Ltd, China), and similar treatment parameters were used in the treatment of these carcinomas. The purpose of these studies is to investigate the safety, efficacy and feasibility of HIFU for the treatment of hepatocellular carcinoma (HCC) and metastatic liver cancer (MLC).

From March 1998 to October 2001, a total of 474 patients with liver cancer, including primary and metastatic liver cancer, have received HIFU treatment at ten hospitals in China. Almost all patients had unresectable hepatocellular carcinoma (HCC) ranging from 4 cm to 15 cm in diameter. The diagnosis of HCC was determined by means of either US-guided biopsy or from the combination of diagnostic images that show classic manifestations of this tumour and an abnormal α-fetoprotein (AFP) level (>200 μg L⁻¹). Among them, most patients were advanced-stage patients with hepatic cirrhosis, and HIFU was used as a palliative therapy in clinical practice. After the treatment, clinical symptoms, such as appetite, weight loss, discomfort or pain in the liver region, were obviously relieved in 86.6% patients. Serum AFP level was decreased by more than 50% in 65.3% patients. Compared to pre-HIFU images, follow-up MRI or CT examinations showed partial or complete coagulation necrosis of the targeted tumours.

A prospective, nonrandomized clinical trial was performed for the treatment of large HCC in my University. A total of HCC 55 patients with cirrhosis were enrolled in this trial. Among them, 51 patients had
unresectable HCC. Tumour size ranged from 4 to 14 cm in diameter with mean diameter of 8.14 cm. According to TNM classification (6th edition), 15 patients corresponded to stage II, 16 to stage IIIA, and 24 to IIIC. The results showed that HIFU was safe, and no severe side effect was observed after the treatment. Serum AFP returned to normal level in 34% of patients. The overall survival rates at 6, 12, and 18 months were 86.1%, 61.5%, and 35.3%, respectively. The survival rates were significantly higher in patients in stage II than those in stage IIIA (P < 0.0132) and in stage IIIC (P < 0.0366).

A randomized, controlled clinical trial was also performed to assess the local therapeutic efficacy of HIFU therapy combined with transcatheter arterial chemoembolization (TACE) and TACE alone for 50 patients with stage–IV A HCC (TNM classification, 5th edition) at our tumour center in Chongqing, China. 11 Of these, 26 patients underwent TACE alone and the remaining 24 patients underwent TACE followed within 2 to 4 weeks by HIFU ablation. The tumour size was 4 to 14 cm in diameter (mean 10.5 cm). All patients were followed from 3 to 24 months (mean 8 months) to observe long-term therapeutic efficacy and complications in both groups. Tumour reduction rates, median survival time, and cumulative survival rates in both groups were calculated using unpaired Student t-test and Kaplan–Meier method. The results indicated that no severe complication was observed after HIFU. Follow-up imaging showed absence or reduction of blood supply in the lesion when compared to TACE alone. The median survival times for patients were 11.3 months in the HIFU plus TACE group and 4 months in the TACE group (P = 0.0042). The 6-month survival rate of patients was 80.4–85.4% in the group 2 and 13.2% in the group 1 (P = 0.0029), and the 1-year survival rate was 42.9% and 0% respectively.

Prospective non–randomized clinical trials are being performed to evaluate the safety and effectiveness in the treatment of metastatic liver cancer. They are phase I and II trials in which same Chinese ultrasound-guided HIFU is used at the Churchill Hospital in Oxford, UK. From November 2002 to August 2004, a total of 22 patients with metastatic liver cancer were treated with HIFU. Using either radiological images such as MRI and contrast ultrasound, or histological examinations, 20 patients were assessed.12 The result indicated that HIFU exposure resulted in discrete ablation zones of liver tumours in all patients (100%). The adverse event profile was favorable when compared to open or minimally invasive techniques.

Because HCC is frequently seen in the setting of hepatic cirrhosis, local therapies, such as surgery and minimally invasive modalities, can be performed in only 20% of patients with HCC. Most of HCC patients lose the chance to be treated due to the presence of multiple bilateral lesions, tumour invasion of the portal vein and underlying advanced liver cirrhosis. In conclusion, as a noninvasive modality, HIFU ablation is a safe, effective, and feasible for the treatment of liver tumours. The experiences achieved in China for the treatment of unresectable HCC indicate that HIFU may be used as an alternative modality for patients unsuitable to conventional therapies. For these patients, HIFU may have the potential to change the patient outcome dramatically.

References

Current Position

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Academic Appointment

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Education
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1983 BSc (Medicine) Chongqing Medical University, China Medicine

Professional Experience
1978-1983  
Student for Bachelor of Medicine, Chongqing Medical University, China

1983-1987  
Resident Surgeon & Chief Resident Surgeon, Department of Surgery, the 2nd Affiliated Hospital of Chongqing Medical University, China

1987-1995  
Chief Resident Surgeon, Department of Paediatric Surgery, The Affiliated Children's Hospital of Chongqing Medical University, China

1988-1994  
Specialist Registrar (SpR), Department of Paediatric Surgery, The Affiliated Children's Hospital of Chongqing Medical University, China

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Clinical Research Fellow (Hon. SpR), Department of Paediatric Surgery, The Affiliated Children's Hospital of Chongqing Medical University, China

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Assistant Professor, Department of Paediatric Surgery, The Affiliated Children's Hospital of Chongqing Medical University, China

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2004-Now  
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**Teaching Experience**

1990-1993  
Teaching lecture topic: Pediatric Surgery  
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1994-1997  
Teaching lecture topic: General Surgery: Pediatric Surgery  
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1998-Now  
Teaching lecture topic: Surgical Oncology: Minimally invasive modality for tumour therapy  
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