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Initial institutional experience of uncooled single-antenna microwave ablation for large hepatocellular carcinoma

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AIM: To evaluate the safety, efficacy, and feasibility of a novel microwave generator, designed to deliver automatically adjusted energy by tissue permittivity feedback control into the tumour via an uncooled antenna, in patients with larger hepatocellular carcinoma (HCC).

MATERIALS AND METHODS: Fourteen patients with HCC >5 cm in diameter received surgical or percutaneous microwave ablation with more than 12 months of follow-up. Microwave ablation was performed using a 902–928 MHz generator at 28 W; a single 14 G antenna without water-cooled system was used. The patients were followed up with contrast-enhanced CT and serum alpha-foetoprotein to monitor for tumour recurrence at 1 month and then every 3 months after tumour ablation.

RESULTS: The follow-up duration for the 11 male and three female patients (mean tumour size 5.77 cm, range 5–7 cm; mean age 63.8 years) was 15.8 months. The mean ablation time was 2025 s (range 900–3600 s), and the mean ablation session was 2.5 (range 1–4). The complete ablation rate was 85% (17 of 20). Local recurrence rate was 5.8% (1 of 17). All patients survived and the morbidity and mortality rate was 21.4% and 0%, respectively.

CONCLUSIONS: Microwave tissue ablation using this novel system with tissue permittivity feedback control and a single uncooled antenna has a high complete ablation rate and lower morbidity. It proved to be a fast, easy, and effective option for ablation of large (>5 cm) tumours.

Introduction

Local tumour ablation techniques have been developed to treat small hepatocellular carcinomas (HCCs) that are not amenable to surgical resection.[1] Radiofrequency ablation (RFA) is the most common local ablative modality due to its efficacy and safety.[2,3] However, a high local recurrence rate, particularly of larger tumours, is a point of concern.[3,4] Other

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criticisms of this technique have focused on the problem of incomplete tumour ablation near large blood vessels due to the so-called heat-sink effect, which detracts from heating efficacy in the ablation zone.[5]

Microwave ablation (MWA) therapy is another hyperthermic treatment modality, which has been extensively applied to treat liver and lung tumours.[6] This technique involves the emission of electromagnetic microwaves from needle-like antennas into the target tissue. Kinetic energy associated with the subsequent agitation of water molecules creates a hot area in the surrounding tissue. MWA offers several advantages over RFA, including shorter ablation time when dealing with tumours of large volume, a higher target temperature, and no requirement for ground pads.[7,8]

The newly designed Medwaves MWA system provides a tissue permittivity feedback control mechanism that allows real-time monitoring of ablation conditions as well as modulation of the power and frequency of microwave energy.[9] Maximizing the amount of delivered forward power increases active heating, such that cellular death in the target area is induced more uniformly, using only a single uncooled antenna.[9] The objective of the present study was to evaluate the safety and efficacy of the novel microwave system with an uncooled antenna in the treatment of patients with HCCs exceeding 5 cm.

Material and methods

Patient population

A total of 14 patients, diagnosed with fewer than three unresectable HCCs (diameter range 5–7 cm), were recruited between July 2012 and Feb 2013 from National Taiwan University Hospital. Diagnosis was settled by typical imaging criteria, including triphasic spiral CT and elevated serum alpha-foetoprotein (AFP) levels. No indications of vascular invasion or extra-hepatic metastases were observed in these patients during tumour ablation. All of the enrolled patients provided informed consent before undergoing the thermal ablation procedure. This study was approved by the research ethics committee of National Taiwan University Hospital.

The study group included 11 male and three female patients, with a mean age of 64.79 years (range 36–82 years). Follow-up for all 14 cases extended for 13–19 months, with a mean of 15.8 months. This period included the first follow-up at 1 month post-MWA and every 3 months after that.

MWA system

A Medwaves AveCure Microwave Generator (San Diego, CA, USA; frequency of 902–928 MHz, modulated power output of 10–32 W) using a 14 G antenna (straight needle, shaft length of 15 cm, and 4 cm active microwave field radiating proximally from the tip) were used to deliver microwave energy into the target area under tissue permittivity feedback control (Fig 1). For all cases in the study, the unit was operated under the fixed-power delivery setting. The generator maintained a temperature range of 80–110°C at the active tip of the microwave antenna by cycling operator-selected power on and off throughout the ablation period. The generator shuts down automatically to halt the ablation process when too much energy is returned from the tissue (Fig 2). According to an *ex vivo* preclinical test on bovine liver, an ablation period ranging from 600–900 s results in an ovoid ablation zone that exceeds 5 cm in diameter (Fig 3).

Ablation technique

The selection of surgery or percutaneous procedure was determined according to the feasibility of the percutaneous approach as well as by comorbidities and preference of the

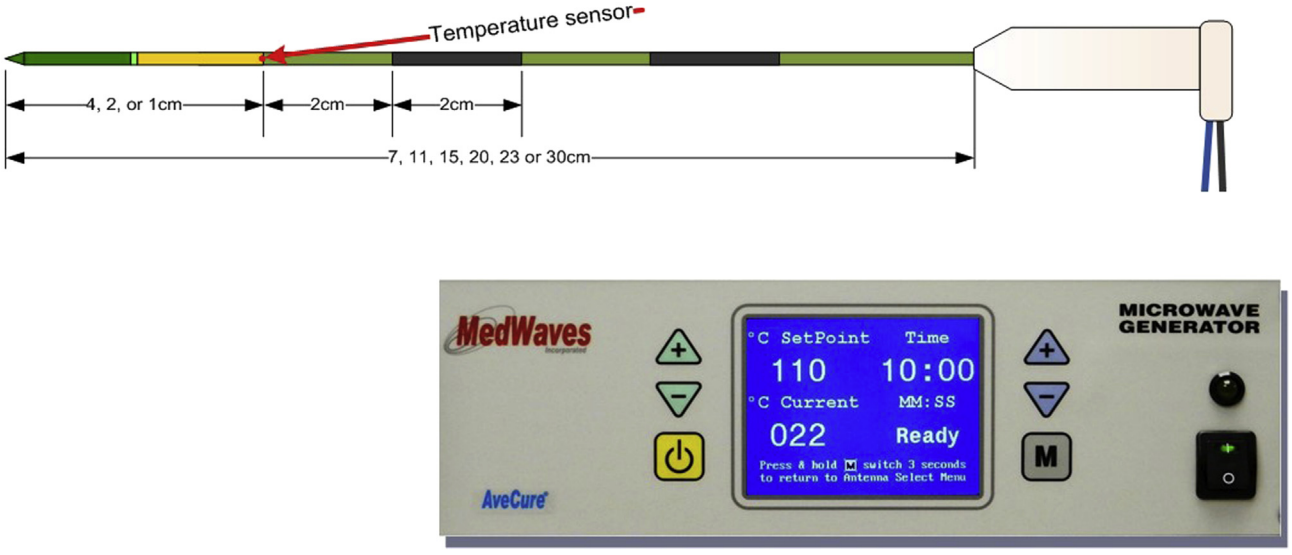

Figure 1 The image of the generator and the antenna.