



Radiofrequency and microwave ablation of subcapsular hepatocellular carcinoma accessed by direct puncture: Safety and efficacy



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ABSTRACT

Objectives: Direct puncture of subcapsular hepatocellular carcinoma (HCC) for tumor ablation has been considered high risk due to a perceived increased incidence of hemorrhage or tumor seeding. The purpose of this retrospective multicenter study was to identify the rate of tumor seeding, hemorrhage and local tumor progression (LTP) associated with direct puncture radiofrequency (RF) and microwave (MW) ablation of subcapsular HCC.

Methods: A multicenter, retrospective review of direct-puncture RF and MW performed on subcapsular HCC was conducted. Complications and local tumor progression were documented. Data was analyzed using Kaplan–Meier and log-rank tests.

Results: The study group consisted of 60 cirrhotic patients (M/F=43/17; mean age 69.6 years) with 67 subcapsular HCC (mean diameter 2.3 cm ± 1.0 cm) that were directly punctured for RF (n=40) or MW (n=27) under ultrasound (US) guidance. The mean follow-up period was 30.8 months. There were no hemorrhagic complications. The overall LTP rate was 13.4%. There was one case of tumor tract seeding in a patient who had undergone a percutaneous biopsy two weeks prior to RF.

Conclusions: Thermal ablation of HCC by direct puncture appears safe and effective. There were no cases of intraperitoneal hemorrhage, and tumor seeding was seen in a single case in which a preceding percutaneous biopsy had been performed.

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1. Introduction

Thermal ablation therapies such as radiofrequency (RF) and microwave (MW) ablation are playing an increasingly important role in the management of hepatocellular carcinoma (HCC) [1]. Ablation is now widely accepted as first-line therapy for very early and early HCC due to a lower complication profile and an over-

all survival equivalent to surgery in several randomized controlled trials [2,3].

Historically, percutaneous treatment of HCC in certain locations (i.e., nodules located in contiguity with Glisson's capsule, exophytic tumors, or those in close proximity to critical vulnerable structures) has been considered high-risk due to a greater potential for incomplete ablation, tumor seeding, hemorrhage, and damage to adjacent organs [4–6]. A subcapsular location has therefore been considered a relative contraindication to ablation.

Some studies have demonstrated that treatment of subcapsular tumors using a needle path traversing normal hepatic parenchyma combined with tract cautery is associated with a low rate of hemorrhagic complications and tumor seeding and local tumor progression (LTP) rates similar to ablation of more central tumors

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[7–11]. The use of artificial ascites does not appear to increase the risk of hemorrhage or tumor seeding in these patients [8,11].

However, treating exophytic and subcapsular tumors with an approach that includes traversing normal hepatic parenchyma is not always possible due to tumor position and the available angles of entry. The purpose of this study was to evaluate our results with direct puncture of subcapsular HCC treated with both radiofrequency and microwave ablation at multiple centers, with specific attention to the rates of hemorrhage, tumor seeding and LTP.

2. Materials and methods

2.1. Patients

This multicenter retrospective study was approved by the institutional review boards of all participating centers. All subcapsular (defined as within 5 mm of liver capsule) or exophytic HCC that underwent ablation between January 2000 and August 2013 were reviewed. Inclusion criteria were the presence of at least one subcapsular HCC nodule up to 4 cm that had been directly punctured because of a lack of other feasible approaches and compensated cirrhosis. Sixty patients with a total of 67 HCC nodules met the inclusion criteria (M/F=43/17; mean age 69.6 years). These nodules represented 2.6% of 2380 HCC tumors treated by percutaneous ablation at the participating centers over this time period.

Diagnosis of HCC was based on American Association for the Study of Liver Diseases (AASLD), European Association for the Study of the Liver (EASL) and Asian Pacific Association for the Study of the Liver (APASL) imaging guidelines, and in only two cases was biopsy deemed necessary [12–14]. All patients had absence of vascular invasion or extrahepatic spread at the time of pre-treatment imaging.

2.2. Thermal ablation techniques

Percutaneous RF or MW procedures were performed by one of the physicians (G.F., M.F. M., I. D., F.L., S.S.) at the involved centers with experience ranging from 1–20 years in ultrasound-guided interventional diagnostic and therapeutic procedures.

All procedures were performed under real-time US guidance with 2.5–6 MHz transducers (Aplio SVG, Toshiba, Japan; H21Hitachi, Japan; alpha 10-Aloka, Tokyo, Japan; Sequoia, Siemens, USA; IU-22 Philips Healthcare, USA; Logiq 9, GE Healthcare, USA). All procedures were carried out in the operating room with the patients under either general anesthesia with endotracheal intubation or conscious sedation according to local policy.

Hydrodissection was used in 13 patients with the purpose of shielding the body wall from unintended thermal damage. The hydrodissection technique consisted of placement of an 18 gauge spinal needle into the peritoneal space under real-time US guidance, followed by the injection of approximately 1000 ml of 5% dextrose-in-water or normal saline.

2.3. Ablation equipment

RF ablation of 40 HCC was performed using one of two straight internally cooled electrodes (E Series–Covidien IIC–MA, USA; RFA-HS-AMICA, Hospital Service, Aprilia, Italy). The algorithm of energy deposition followed the manufacturers' recommended protocol for their device. More than one insertion was planned if nodule size exceeded 3.0 cm. The remaining 27 tumors were treated using one of two 2.45 GHz MW systems at powers between 40 and 140 W using 14–17 gauge internally cooled antennas (HS Amica, Hospital Service, Aprilia, Italy; Certus 140, NeuWave Medical, Madison WI, USA). The power, number of antennas, number of insertions and total treatment time varied according to the size of the tumor and

Table 1

Main demographic and clinical characteristics of the patients studied.

No. Patients	60
M/F	43/17
No. nodules	67
Mean age (SD) years	69.7 (8.9)
Mean nodule size (SD) mm	2.3 (1.0)
No exophytic nodules 10–50%/>50%	14/5
HCV+/HBV+/alcohol/other	43/7/6/4
Child's class A/B	55/5
Mean value of serum AFP (SD) ng/ml	116.5 (229.3)

Abbreviations: HVC = hepatitis C virus.

HBV = hepatitis B virus.

AFP = alpha-fetoprotein.

the response to treatment based on real-time US imaging. In all cases, the goal of treatment was complete ablation of the targeted tumor and a 5–10 mm margin.

In all cases a direct puncture of the tumor was performed without passing through a cuff of normal liver parenchyma (Fig. 1), and the entire needle path was cauterized upon completion of the ablation with manufacturer recommended parameters. The presence of residual viable tumor was evaluated between 5 and 10 min from the end of the procedure using either contrast enhanced US (SonoVue, Bracco, Milan, Italy) or contrast enhanced CT (Omnipaque 300, Lightspeed Xtra, GE Healthcare, Waukesha, WI). If residual enhancing areas were detected, immediate re-treatment was performed.

2.4. Complications

The type and number of complications were recorded and classified according to Society of Interventional Radiology (SIR) guidelines [15]. Patient medical records and follow up CT and MRI studies were examined for evidence of peritoneal hemorrhage and tumor seeding. Follow-up protocol included clinical assessment, measurements of liver function and alpha-fetoprotein levels, and US examination every 3 months and abdominal CT or MRI exam once or twice in a year according to local policy. Local tumor progression (LTP) was defined as evidence of residual, enhancing untreated tumor, the development of new enhancing nodules on the periphery of the ablation zone during follow-up CT or MRI, and interval growth of the ablation zone after the initial post-procedure imaging session.

2.5. Statistics

Means, standard deviations, ranges, and frequencies were used as descriptive statistics for patient baseline characteristics. The cumulative rates of LTP during the follow-up period were estimated using the method of Kaplan–Meier and reported with 95% confidence interval. All statistical analyses were performed using NCCSS 2007 Statistical Software (<http://www.ncss.com/>).

3. Results

3.1. Clinical characteristics

Table 1 summarizes the main demographic and clinical characteristics of the study group. The mean tumor size (s.d.) at diagnosis was 2.3 cm (1.0 cm). Nodules with an exophytic component comprised 25.3% (17/67) of all tumors in the study population.

3.2. Tumor control

Patients were followed for a mean of 30.8 months post-ablation (range 1–162 months). Local tumor progression was observed in 9

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