ORIGINAL ARTICLE

Efficacy and Safety of Percutaneous Radiofrequency Ablation of Hepatocellular Carcinoma in a Regional Hospital

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ABSTRACT

Objective: This study was performed to assess the treatment effectiveness and safety of percutaneous radiofrequency ablation of hepatocellular carcinoma in a regional hospital.

Methods: This was a retrospective review of percutaneous radiofrequency ablation of hepatic tumours performed at the Department of Radiology, Tuen Mun Hospital, Hong Kong, from July 2005 to March 2008. Sixty seven ablative procedures were performed, of which 47 were percutaneous ablations. Thirty five percutaneous radiofrequency ablations of hepatocellular carcinoma with a curative aim were performed on 52 hepatocellular tumours in 32 patients. Patients underwent regular computed tomography imaging of the liver during follow-up and the treatment effectiveness and safety were evaluated. Incomplete ablation, recurrence, complications, and mortality were documented.

Results: At 1 month, 48 of 52 tumours (93%) of hepatocellular carcinoma had complete ablation. The primary technical effectiveness rate was 82.7%. The secondary technical effectiveness rate was 92.3%. The rate for minor complications was 4.7%. There were no major complications. There were 2 deaths (4.7%), 1 of which may have been procedure-related.

Conclusions: Radiofrequency ablation of the liver is safe and feasible in a regional hospital. These results for treatment effectiveness and complication rates are comparable with previous studies.

Key Words: Ablation techniques; Carcinoma, hepatocellular; Radiation oncology

INTRODUCTION

Hepatocellular carcinoma (HCC) is the second most common cause of cancer death among men in Hong Kong.[1] Even though liver transplantation or hepatic surgeries are the best curative options for HCC, with good survival rates, only a minority of patients are candidates for liver resection. At the time of diagnosis, more than 80% of patients have inoperable tumours because of comorbidities, poor hepatic reserves, or an inability to obtain an optimal tumour-free margin. Therefore, loco-regional treatment is the mainstay of treatment. Radio-frequency ablation (RFA) has been widely adopted as a curative treatment for small HCC tumours (<3 cm) with satisfactory efficacy.[2-4] This study was performed to assess the effectiveness and safety of percutaneous RFA for hepatic lesions at a regional hospital.

METHODS
Design

From July 2005 to March 2008, RFA was performed for 90 hepatic lesions in 60 patients. Among the hepatic lesions, 84 were malignant tumours, of which 78 (86.7%) were HCC and 6 (6.7%) were metastatic lesions (5 primary colonic carcinomas and 1 rectal carcinoma). The remaining 6 lesions were histologically proven to be dysplastic. Sixty seven ablative procedures were performed, of which 47 were percutaneous ablations performed in 43 patients. Thirty five percutaneous RFAs of HCC with curative aim were performed on 52 lesions in 32 patients. During follow-up regular computed tomography (CT) scans of the liver were performed to assess the tumour status according to a protocol of CT imaging at day 0 and months 1, 3, 6, 9, 12, 18, and 24 after ablation. Biochemical markers,

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including α-foetoprotein and liver function tests, were regularly checked to monitor disease progress.

The treatment effectiveness and the safety of the procedure were retrospectively reviewed. Incomplete ablation, new tumour deposits, complications, and mortality were documented.

Procedure

Treatment was performed with the patient sedated and analgesia was given. Vital signs were continuously monitored during the procedure. RFA was performed under ultrasound or CT guidance. For most patients, both imaging techniques were used for tumour localisation and needle entry. The most appropriate approach for electrode insertion was selected based on tumour location and size. For lesions located in the right lobe, an intercostal approach was preferred, with the patient in the left oblique position. For tumours located in the left lobe, a subcostal approach was used. If the tumour was close to adjacent structures such as the diaphragm, kidney, gallbladder, or bowel, artificial ascites or pleural effusion was performed by instilling 5% dextrose solution 1 to 2 L until there was satisfactory space for needle insertion and sufficient separation from the nearby organs.

Two types of electrodes were used: 18-G internally cooled electrodes (Valleylab Cool-tip™ RF Ablation System; Valleylab, Boulder, USA) and the 15-G LeVeen® electrode (Boston Scientific, Natick, USA). The selection of the electrode type was based on the size and location of the tumour. For tumours measuring 2 to 3 cm in diameter, a single electrode with 2 or 3 cm of exposed metallic tip was used. For larger tumours, a multitined expandable LeVeen needle with an umbrella-shaped array or a cluster triple electrode (Valleylab Cool-tip RF Ablation System) with 3 internally cooled electrodes was used.

Dispersive electrodes or grounding pads were attached to the patients' thighs. Both RFA systems were connected to their designated generators, which have an impedance-based feedback system designed to accurately monitor the extent of tissue desiccation and permit continued delivery of radiofrequency energy. Both generators are capable of producing 200 W of power. For the Valleylab Cool-tip RF Ablation System, the electrodes were attached to a 500-kHz RF generator (CC-1; Radionics Inc, Burlington, USA). For the LeVeen electrode, the electrodes were connected to the RF 3000® Generator (Boston Scientific). The progress of tissue ablation was monitored by the impedence to signify the end of the procedure according to the ablation protocol provided by the manufacturer. The ablation time of each cycle was 12 minutes for the Valleylab Cool-tip RF Ablation System and up to 20 minutes for the LeVeen electrode system. Following ablation, the patient stayed overnight in the hospital, even in the absence of complications.

Definitions and Analysis

To facilitate comparison with other published studies, the recommendations of the Society of Interventional Radiology were followed to define the results.[5] Technical effectiveness was defined as the number of tumours that were completely ablated after a certain follow-up time. Minor complications were defined as absence of or nominal therapy without consequence, including overnight admission for observation. Major complications were defined as complications that required therapy, short or prolonged hospital admission, or adverse sequelae. The procedure safety was based on the number of ablative sessions. Since the tumour histology type should not affect the safety results, all 47 percutaneous RFA procedures in 43 patients were included in the safety analysis.

RESULTS

Demographic Characteristics

There were 52 tumours among 32 patients. Twenty seven (84.3%) of the patients were men and 5 (15.6%) were women. Twenty three patients (71.9%) were hepatitis B carriers, and 5 (15.6%) were hepatitis C carriers. The mean age of the patients was 64.1 years (SD, 12.2 years). Most of the patients had Child-Pugh stage A or B cirrhosis.

Characteristics of Hepatocellular Carcinoma

The mean size of each tumour was 2.09 cm (SD, 0.85 cm). Forty eight tumours (92.3%) were located in the right lobe and 4 (7.7%) were in the left lobe. Segment 8, according to Courinaud's classification, was the most common site; 19 tumours (36.5%) were located in this segment. Thirty five percutaneous ablation procedures were performed, with an average of 1.44 tumours ablated per session. The mean follow-up time was 14.6 months (SD, 9.6 months).

Treatment Effectiveness

At 1 month, 48 of 52 tumours (93%) showed complete ablation. For primary technical effectiveness, 43 tumours

Table 1. Complications and mortality after radiofrequency ablation (n = 43).

Complications	Number of patients (%)
Minor	2 (4.7)
Small pneumothorax not requiring drainage	
Small pleural effusion not requiring drainage	
Major	0 (0)
Procedure-related mortality	1 (2.4)
Multiorgan failure and sepsis 23 days after ablation	

(82.7%) were completely ablated after the initial procedure, and 48 (92.3%) were completely ablated after the second procedure.

Five tumours (9.6%) showed growth around the ablation zone on follow-up CT scans after complete ablation and tumour necrosis was demonstrated on the initial CT scans. All the tumours that progressed were detected within 3 to 6 months of RFA.

Procedure Safety

The 7-day mortality rate was 0, the 30-day mortality for any reason was 2 (4.7%), and the procedure-related mortality rate was 1 (2.4%). A 66-year-old patient died 23 days after the procedure due to multiorgan failure and sepsis. There was no evidence of haemorrhage or abscess formation in the ablation zone by CT imaging, but the sepsis may have been procedure-related. An 80-year-old patient with comorbidities died of a chest infection 10 days after the procedure.

There were 2 minor complications of a small pneumothorax and pleural effusion, neither of which required chest drainage, providing a minor complication rate of 4.7%. There were no major complications. The complication rates are summarised in Table 1.

DISCUSSION

The efficacy of tumour ablation and the safety of percutaneous RFA ablation of hepatic lesions have been described by various researchers.[6-11] The results of this study are comparable with the published data. The technical efficacy of complete tumour ablation of small tumours (<3.5 cm) has been reported to be 76% to 96%, with a mean of 1.2 to 1.4 ablation sessions per tumour.[6-11] The technical efficacy in this study was 82.7% to 92.3%. The reported rate of local tumour progression after various ablative techniques for HCC ranges from 2% to 60%.[5,7-10] In this study, 9.6% of tumours progressed after complete ablation. Local tumour progression can develop at the margins of an ablation zone if the margin is inadequately

ablated as residual microscopic tumour may be present and continue to grow. The preferred ablative margin is 0.5 to 1 cm surrounding the tumour.

The procedure-related mortality rate in this study was 2.4% and there were no other major complications; the minor complication rate was 4.7%. The reported mortality rate is 0% to 0.3%, and the major complication rate ranges from 1.8% to 4.0%.[5,7-10] Both intraoperative and percutaneous RFA were evaluated in the reported studies.[5,7-10] For procedure-related mortality, the reported causes included hepatic infarct followed by hepatic failure, cardiac tamponade and respiratory arrest due to an adverse reaction to the anaesthetic, intestinal perforation, peritonitis, massive haemorrhage, and death within 3 days of ablation.[7,8,12-15] However, the time of mortality after ablation was not stated in many of the previous studies. Therefore, it was not possible to compare mortality rates between studies.

The results of this study are limited by the small sample size affecting the value of the calculated percentage for the complication and mortality rates. Nevertheless, the results for therapeutic efficacy of RFA and complication rates are comparable with those reported in the literature. With the increasing amount of research on loco-regional and ablative methods for managing tumours, standardised terms and definitions are needed to facilitate comparison between different treatment modalities.[5]

This study showed that RFA is a safe and feasible treatment for the management of HCC in a regional hospital. However, the procedure requires dedicated techniques and expertise. Case planning and case selection are important to achieve a curative aim. An understanding of the anatomical location of the tumour is needed to assess the feasibility of the procedure and the approach for the ablation. This can be achieved by evaluating the tumour in a 3-dimensional image, correlating the tumour configuration with the configuration and size of the RFA zone of each specific type of electrode, and planning the direction of the electrode path relative to the tumour configuration.[5] For lesions that cannot be reached via the percutaneous approach, laparoscopy or laparotomy may be needed to achieve complete ablation. Techniques such as the creation of artificial ascites or pleural effusion will enable suboptimally located tumours to be treated by percutaneous RFA.[15] With increasing experience and advances in techniques and imaging guidance, RFA could be performed in a safer more effective manner.

Combining RFA with percutaneous ethanol injection (PEI) and transarterial chemoembolisation (TACE) has shown promising results.[16-19] These measures could improve the results of complete ablation for tumours located suboptimally for RFA. Tumours that are located in close proximity to blood vessels, liver capsule, and vital structures are considered to have a high risk for treatment failure and complications. These sites are difficult to approach percutaneously because of restriction of the needle insertion angle by the ribs, sonographic interference by air in the lungs, or less than optimal positioning of the electrode to avoid injury to an adjacent vital organ. In the presence of a nearby vessel of ≥3 mm in diameter, the heat-sink effect is considerable and could jeopardise the efficacy of RFA by causing a significantly smaller diameter and volume of ablation-induced coagulation necrosis and lower complete ablation rates.[20] PEI induces coagulation and obliteration of small intratumoural vessels, and it has been shown that performing PEI before RFA facilitates a larger area of coagulation necrosis than that obtained with RFA alone.[21] The combination of RFA and PEI for the management of HCC in high-risk locations has a slightly higher primary effectiveness rate than does RFA alone.[17] A combination of TACE and RFA has been used for large tumours, and has a better survival rate than that for patients treated with RFA alone for tumours >3 cm.

RFA is a feasible procedure in terms of safety and efficacy. However, successful management of HCC relies on multimodality treatments. Therefore, a team approach and close liaison with the hepatobiliary surgeons and oncologists is necessary to provide the best care to patients.

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