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Effect of one-off complete tumor radiofrequency ablation on liver function and postoperative complication in small hepatocellular carcinoma

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Abstract

Objective: Radiofrequency ablation (RFA) is effective in treating hepatocellular carcinoma (HCC) and less invasive than surgical resection. However, 'one-off' complete tumor ablation on liver function has not been reported.

Methods: We retrospectively reviewed 36 HCCs which met the criteria of 'one-off' complete tumor ablation: (1) tumor was completed covered by the ablated zone (confirmed by postoperative enhanced CT) with a single RFA and, (2) no sign of recurrence for at least 6 months. We categorized tumors into two groups: near vascular tumor (NVT) if the distance was less than 5 mm, and far vascular tumor (FVT) otherwise.

Results: Thirteen HCCs met the criteria of NVTs, and 23 HCCs met that of FVTs. The Average tumor size was 2.6 ± 0.3 cm in FVTs and 2.5 ± 0.3 cm in NVTs. Although restored to normal range by postoperative day (POD) 7, ALT, AST, total bilirubin (TB), albumin and prothrombin time showed more significant fluctuation in NVTs compared to those in FVTs on POD1 through POD5. Moreover, 53.9% (7/13) patients in NVT group and 26.1% (6/23) in FVT group developed post-RFA transient ascites (OR = 5.1, 95% CI = 1.1–24.4). Incidence of post-RFA pleural effusion were 61.5% (8/13) in NVT but only 17.4% (4/23) in FVTs (OR = 7.6, 95% CI = 1.6–35.9).

Conclusion: 'One-off' complete tumor ablation may impair liver function and led to more postoperative complication if a tumor is within 5 mm away from a large blood vessel (≥3 mm). Particular caution should be made in preoperative assessment on the anatomic relation between tumor and large blood vessel for patients.

Keywords: Small hepatocellular carcinoma; Radiofrequency ablation; One-off complete tumor ablation; Liver function; Postoperative complication; Large blood vessel; Superficial tumor; Deep sited tumor; Liver parenchyma; Heat Sink Effect; River Flow Effect

Introduction

Most patients with hepatocellular carcinoma (HCC) in China are associated with liver cirrhosis.[1] Some of them showed decompensated liver function when they were first diagnosed which is contraindication for surgical resection.[2] Before a choice is made from various therapeutic options for HCC, it is critical to assess preoperative hepatic functional reserve and predict possible postoperative complication caused by decompensated liver function.[2,3] Among the less invasive therapeutic options, radiofrequency ablation (RFA) has been shown to be a safe regional tumor therapy with less liver function damage.[4] RFA is becoming widely accepted as a minimally invasive treatment for the management of primary or secondary liver malignancies. The benefits over surgical resection are safety, lower mortality, less morbidity, and shorter hospitalization.[4–7]

However, most investigators supported the fact that overall survival and disease-free benefit of RFA are inferior to surgical resection in most of controlled studies.[8,9]

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Huang[6] et al. also conducted another RCT with 230 patients fulfilling the Milan criteria and confirmed the superiority of surgical resection to RFA. The benefits of liver resection are further supported by data concerning quality of life survival, which seem to favor resection over RFA, at least in cirrhotic patients.[4,5,10] Interestingly, Chen[11] et al. compared the results of percutaneous local RFA with that of surgical resection in the treatment of solitary and small hepatocellular carcinoma (HCC) in a prospective randomized trial of 180 patients each with a solitary HCC 5 cm or less. Patients received either percutaneous local ablative therapy or surgical resection. Local RFA was as effective as surgical resection in the treatment of solitary and small HCC. Even percutaneous local RFA had the advantage over surgical resection. Incomplete tumor ablation[12] (incomplete thermal tissue destruction), which is presented insufficient ablation coverage, may compromise both disease-free and survival benefits of RFA.[13,14]Obviously, the major cause of inadequate tumor ablation were from the concern of postoperative decompensated liver function and severe complications.[15]

In this study, we respectively reviewed 36 cases of small HCCs (maximal diameter is 3 cm). We interpreted the results by adapting to the concept of radical tumor removal by surgical resection to RFA and proposed a terminology so called 'one-off' tumor ablation. The objective of this study was to assess postoperative liver function and complications after 'one-off' complete tumor ablation.

Patients and methods

Study design

Our study, approved by the Healthcare Ethics Committee Institutional Review Board (IRB) of our hospital, was to determine post-RFA liver function and complication in small HCCs. Data of all these HCCs were captured from medical and follow-up records. These tumors were treated with so called 'one-off' tumor complete ablation, in which the criteria was (1) tumor achieves complete ablation (hypodense and non-enhancing lesion shown by contrast CT) by a single RFA session, and (2) no local residual or recurrent tumors for at least 6 months. All patients had at least one preoperative CT. Although some patients had both CT and MRI, we determined the tumor size and distance from the vessels exclusively by CT in order to be comparable. We reviewed tumor imaging and determine the distance between an eligible tumor and its nearest 3 mm diameter blood vessel. We then divided tumors into two groups for analysis: near vascular tumor (NVT) if the tumor was near a 3 mm-diameter blood vessel within 5 mm or less, and far vascular tumor (FVT) if the tumor was more than 5 mm away from 3 mm diameter blood vessel. We compared liver function and other post-RFA complications between NVTs and FVTs.

Diagnosis of HCC

HCC was diagnosed according to the American Association for the Study of Liver Diseases guidelines.[16] The diagnosis was confirmed by at least 2 dynamic imaging techniques. The typical findings of classical HCC are hyperattenuation at the arterial phase, hypoattenuation at the portal phase as observed in dynamic CT or MRI, and tumor staining on angiography.

Inclusion and exclusion criteria

Inclusion criteria were as following: tumor size less than 3 cm, Child–Pugh A or B, and 'one-off' tumor complete ablation (determined by postoperative CT and disease free up to 6 months follow up).

Exclusion criteria included: multiple tumor lesions (2 or more), recurrent tumor, extra-hepatic tumor metastasis, portal thrombosis/embolus and existing preoperative ascites upon pre-operative assessment.

Laparoscopic RFA

Laparoscopic procedures, as described previously,[7,14,17] were performed in all 36 patients under general anesthesia. Briefly, a 12-mm Hasson trocar was inserted into the left peri-umbilical mini-incision. Another 12-mm trocar was placed in the middle upper quadrant of the abdomen for the ultrasound (US) probe. The last 5-mm trocar was inserted in the right lower quadrant of the abdomen on the mid-clavicular line in order to secure the liver. Once the patient was ready for the procedure, the intraoperative US was first used to confirm lesions. A percutaneous puncture was made at 1–5 cm below the costal margin, or through the right intercostal space according to tumor location, and a 17-gauge single electrode 3 cm active-tip (Covidien™, Boulder, CO, USA) was accurately placed. For superficial tumors more than 2–3 cm in diameter, electrodes were placed at the center of tumor. For tumors less than 2 cm in size, electrodes were placed at the bottom of the tumor. For deep sited tumors, we placed electrodes into the tumor center but kept away from large blood vessel or bile duct branches. Afterwards, the position of the electrode was checked again with US to ensure it was away from large blood vessels and bile ducts. Radiofrequency ablation (RFA) was conducted using Cool-Tip™ RF Ablation System (Valleylab™, Boulder, CO., USA).

All tumor ablation began with a low power heating at 70–90 W for 6 min in order to avoid the tumor rupture due to sudden elevation of intra-tumor temperature. Subsequently, the output power was adjusted by the device's self-balancing feedback system to reach its maximal power at 200 W and tumor was heated for 24 min. For superficial tumors, color changes (from gray to dark yellow) were seen in both the tumor and adjacent hepatic tissue. For deep sited tumors, color change was also found in corresponding