Radiofrequency Ablation for Hepatic Malignancies: Is Needle Tract Cauterization Necessary for Preventing Iatrogenic Bleeding?

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Key Words

Bleeding · Complications · Hepatic malignancy · Needle tract cauterization · Radiofrequency ablation

Abstract

Objective: To evaluate whether iatrogenic hemorrhage can be prevented by intrahepatic tract ablation following radiofrequency ablation (RFA) therapy for hepatic malignancies.

Methods: A retrospective cohort study analyzing a prospective database in a single institution was conducted. The incidence of postprocedural complications was compared in two groups: one with cauterization of the needle tracts after RFA and the other without. **Results:** The complication rates of intraperitoneal hemorrhage were 1.05% (4/380) and 0.92% (6/652) in the nonablation group and the ablation group, respectively ($p = 0.90$). All of these 10 patients with iatrogenic bleeding were classified as Child-Pugh grade A. Among the 15 hemodialysis patients in this study, hemorrhage was seen in 2 (13.3%), compared with 8 (0.79%) of the nonhemodialysis patients ($p = 0.0002$). There were no statistically significant differences in the incidence of other complications including pleural effusion, serous ascites, pneumothorax, hemothorax, hepatic infarction, bile duct injury and pericardial effusion between the two groups. Gastrointestinal perforation, peritonitis or tumor seeding were not observed. **Conclusion:** Our study found a high incidence of

bleeding after RFA among hemodialysis patients. Irrespective of tract ablation being after RFA, iatrogenic hemorrhage appeared to be equivalent in this population.

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Introduction

Percutaneous radiofrequency ablation (RFA) has been accepted as a safe and effective technique for the treatment of unresectable hepatic primary and metastatic malignancies [1–8]. Although the advantages of the use of RFA include low mortality and morbidity [9], early detection and treatment of complications is essential for a favorable RFA outcome.

General complications of RFA may be related to imaging-guided electrode placement (e.g. bleeding, arterial-portal shunt, tumor seeding, pneumothorax), thermal therapy (e.g. nontarget thermal damage, grounding pad burns) or others (e.g. infection, infarction) [10–13]. Intraperitoneal bleeding is a serious complication that can result in mortality if not appropriately managed. This bleeding can develop from direct mechanical injury to the vascular structure by the radiofrequency (RF) needle electrode rather than from RF thermal injury to the vessel. Thus, the potential for bleeding depends on placement of the RF needle electrode without traversing major

Fig. 1. Linear hyperechogenicity following RFA was seen along the RF needle tract on B-mode US (arrows).

Fig. 2. An 80-year-old woman with an HCC. Contrast-enhanced CT showed that the ablated tumor (arrow) was not enhanced in segment VI of the liver. The ablated needle tract is depicted as a low-density line (arrowheads).

vessels and minimizing the amount of needle repositioning. In addition, cauterization of the needle tracts is thought to prevent bleeding after percutaneous RFA. However, to our knowledge, no previous studies have evaluated whether needle tract ablation actually contributes to reducing postprocedural bleeding. The purpose of this study was to assess whether intrahepatic tract ablation following RFA for hepatic malignancies.

Materials and Methods

Patients

Written informed consent to perform percutaneous RFA was obtained from all patients before treatment. This cohort study was conducted as a retrospective analysis of a prospective database in a single institution in which RFAs are routinely performed. After the introduction of RFA, our hospital has conducted procedures with or without intrahepatic tract ablation based on the preferences of two senior doctors. The records of consecutive patients who did or did not receive intrahepatic tract ablation following RFA or not between January 2007 and June 2011 at Kinki University Hospital were reviewed.

Hepatocellular carcinoma (HCC) was diagnosed based on three-phase contrast-enhanced CT findings such as positive enhancement in the arterial phase and washout in the equilibrium phase in patients with chronic liver disease. Liver metastases were diagnosed by ring enhancement on contrast-enhanced CT in patients with past cancer illness. Intrahepatic cholangiocarcinoma has been described as an irregular mass with markedly low attenuation, and minimal peripheral enhancement noted with ancillary findings in dilatation of the peripheral intrahepatic ducts. All patients met the following criteria for treatment with RFA: percutaneous accessibility of the tumors, absence of portal tumor thrombus and extrahepatic metastasis, prothrombin time ratio greater than 50%, total bilirubin less than 4.0 mg/dl and platelet count greater than 30,000/ μ l.

Equipment and Technique

B-mode ultrasound (US) scans were obtained using a LOGIQ 7 (GE Medical Systems, Milwaukee, Wisc., USA) or an EUB 8500 unit (HITACHI Medico, Tokyo, Japan). A multidetector CT (LightSpeed VCT, GE Medical Systems, Milwaukee, Wisc., USA) was used for diagnosis. Triple-phase contrast-enhanced CT scans were performed with a 5.0-mm slice thickness at 30, 60 and 180 s after initiating the injection of contrast media to obtain hepatic arterial-, portal venous- and equilibrium-phase images, respectively. A total of 100 ml of nonionic contrast material containing 300 mg of iodine per milliliter (Iomeprol, Eisai Co., Tokyo, Japan) was injected intravenously at a rate of 3 ml/s using an automatic power injector.

Patients were treated by RFA (Cooled-tip RF ablation system; Radionics, Burlington, Mass., USA). Twenty-centimeter-long, 17-gauge, monopolar internally cooled electrodes with 3- or 2-cm-long exposed metallic tips (Radionics) were used to deliver RF energy. A 200-Watt, 480-kHz monopolar RF generator regulated by impedance (CC-1; Radionics) was used as the energy source.

RFA is mainly performed percutaneously under B-mode US guidance. If necessary, it can also be used under the guidance of contrast-enhanced US or virtual CT/MRI US. After RF energy was delivered, the hyperechoic zone appeared and gradually increased at the ablated site with monitoring to assess the ablation. The ablation was stopped when the entire target (including the safety margin) was completely covered by the zone of hyperechogenicity. In patients with tract ablation, RF energy was delivered again before removing the RF needle. Thereafter, the RF needle was slowly withdrawn so that the linear hyperechogenicity passed along the RF needle tract (fig. 1).

Complications

We assessed the laboratory data obtained before and after RFA, including serum hemoglobin level, prothrombin time and platelet count. Furthermore, we obtained a CT scan of the liver from 1–5 days (median 3 days) after RFA for the assessment of treatment response (fig. 2). The maximum thickness of perihepatic ascites was also recorded using CT scans obtained before RFA and after RFA (fig. 3). We considered hemoperitoneum to be present if the attenuation of ascites had increased around the perihepatic spaces in patients with serum hemoglobin levels reduced by more than 1.0 g/dl in 1 day after RFA.

Fig. 3. A 65-year-old male hemodialysis patient with an HCC 2.5 cm in diameter. Plain CT detected the ablated area by RFA as low density (*). Ascitic fluid appeared and intraperitoneal hemorrhage was depicted as high attenuation in ascites (arrow).

Endpoint and Statistical Analysis

The primary endpoint was the incidence of intraperitoneal hemorrhage after percutaneous RFA. The secondary endpoint was the occurrence of other postprocedural complications during an observation period of at least 1 month after RFA, including pleural effusion, ascites, pneumothorax, hemothorax, hepatic infarction, bile duct injury, pericardial effusion, gastrointestinal perforation and peritonitis, etc.

All values were expressed as mean $\pm$ standard deviation (SD). Comparisons between the two groups were analyzed using Fisher's test. A χ^2 test was used to compare differences in the use of RFA modifications among the four groups. $p < 0.05$ was considered statistically significant. Statistical analyses were performed using SPSS software (version 12.0; SPSS, Chicago, Ill., USA).

Results

Baseline Characteristics of Patients

In total, 1,072 patients with 1,730 hepatic malignancies were enrolled. The patient population included 685 men and 347 women. The maximal diameter of tumors ranged from 0.5 to 11 cm on dynamic CT. Of all 1,072 patients who underwent percutaneous RFA for the treatment, 922 (86.0%) had HCC, 10 (0.9%) had intrahepatic cholangiocarcinoma and the other 99 (9.2%) had liver metastases, mostly from colorectal cancer.

Table 1 shows the characteristics of both groups. The distributions of sex and age were not different between the two groups. In the nonablation group, 316 (83.2%), 62 (16.3%) and 2 (0.5%) patients were classified with

Table 1. Baseline clinical characteristics of patients

Characteristics	Nonablation group (380 patients/ 660 nodules)	Ablation group (652 patients/ 1,070 nodules)	p value
Sex, n			0.56
Male	248	437	
Female	132	215	
Age, years	67.9 $\pm$ 9.5	69.0 $\pm$ 9.8	0.57
Range	33–88	32–90	
Child-Pugh class, n			0.23
A	316	567	
B	62	80	
C	2	5	
Malignancies, n			0.18
HCC	331	591	
Intrahepatic cholangiocarcinoma	5	5	
Liver metastases	45	54	
Tumor size, cm	1.9 $\pm$ 1.1	1.7 $\pm$ 1.1	0.47
Range	0.5–11	0.5–8	
Tumor location in liver subsegments, n			0.19
Left lateral	101	161	
Left medial	92	116	
Right medial	243	448	
Right lateral	220	335	
Segment 1	4	10	

Data are presented as mean $\pm$ SD unless otherwise indicated.

Child-Pugh A, B and C liver function, respectively, whereas 567 (87.0%), 80 (12.3%) and 5 (0.8%) patients in the ablation group were classified into Child-Pugh A, B and C, respectively. The proportions of patients with Child-Pugh classification did not differ significantly.

Of 380 patients in the nonablation group, 596 patients underwent RFA for treatment of their primary liver tumor, including HCC (87.1%; 331/380) and intrahepatic cholangiocarcinoma (1.3%; 5/380). The other 45 (11.8%) had liver metastases including colorectal cancer ($n = 30$), gastric cancer ($n = 6$), ovarian cancer ($n = 1$), pancreatic cancer ($n = 1$), renal cell carcinoma ($n = 1$) and others ($n = 6$). In contrast, in the ablation group, 591 (90.6%), 5 (0.8%) and 54 (8.3%) patients had HCC, intrahepatic cholangiocarcinoma and metastatic liver tumors, respectively. Secondary hepatic malignancies included colorectal cancer ($n = 35$), gastric cancer ($n = 4$), ovarian cancer ($n = 2$), pancreatic cancer ($n = 2$), renal cell carcinoma ($n = 3$) and others ($n = 8$).

The tumor size was not significantly different between the two groups. The mean tumor diameter was 1.9 ± 1.1 cm (range 0.5–11 cm) in the nonablation group, and 1.7 ± 1.1 cm (range 0.5–8 cm) in the ablation group.

Table 2. Complications between groups

Complications	Nonablation group (n = 380)	Ablation group (n = 652)	p value
Intraperitoneal hemorrhage	6 (0.9)	4 (1.1)	0.90
Pleural effusion	27 (7.1)	31 (4.8)	0.11
Serous ascites	8 (2.1)	8 (1.2)	0.40
Pneumothorax	3 (0.8)	6 (0.9)	0.90
Hemothorax	3 (0.8)	4 (0.6)	0.95
Hepatic infarction	2 (0.5)	4 (0.6)	0.81
Bile duct injury	0	4 (0.6)	–
Pericardial effusion	0	1 (0.2)	–

Values in parentheses are percentages.

Intraperitoneal Hemorrhage

Table 2 shows the complications in both groups in this study. No death was considered RFA related.

Procedural hemorrhage occurred in 10 (0.93%) patients (HCC, n = 8; liver metastases, n = 2). In the nonablation group and the ablation group, the complication rates of hemorrhage were, respectively, 1.05% (4/380) and 0.92% (6/652). No significant difference was observed in the incidence of iatrogenic bleeding (p = 0.90). Fortunately, these patients did not need transcatheter arterial embolization for the treatment of iatrogenic bleeding after RFA, and improved with conservative therapy including blood transfusion. Of these 10 patients with bleeding, the platelet counts before ablation ranged from 48,000 to 325,000/ μ l (mean $\pm$ SD 12,600 $\pm$ 8,100). The prothrombin time before ablation was 67–103% (mean $\pm$ SD 85.0 $\pm$ 10.1), and all patients were classified as Child-Pugh grade A (5 points, n = 7; 6 points, n = 3). The mean tumor diameter was 2.1 $\pm$ 0.9 cm (range 0.9–11 cm).

Among the 15 hemodialysis patients in this study, hemorrhage was seen in 2 (13.3%), whereas 8 (0.79%) patients with bleeding were nonhemodialysis (p = 0.0002).

Other Complications

The complications of RFA excluding hemorrhage were pleural effusion, serous ascites, pneumothorax, hemothorax, hepatic infarction, bile duct injury and pericardial effusion (table 2). Gastrointestinal perforation, peritonitis and tumor seeding by RFA was not observed in this study. No significant differences were observed in the incidences of these complications between the two groups. Three patients with pneumothorax (nonablation group, n = 1; ablation group, n = 2) were treated with

chest tube drainage, and the fluid was drained in a patient with pericardial effusion. The other patients with complications subsided after conservative treatments.

Discussion

The overall rate of intraperitoneal hemorrhage for 1,730 ablated lesions was 0.93% in our study, a value that coincides with other experiences. The rates of iatrogenic bleeding treated with percutaneous RFA have been reported to be 0.32–1.6% [14–21]. Arterial bleeding causes robust hemorrhage that could contribute to mortality, and transcatheter arterial embolization would be needed for interventional hemostasis.

When an RF electric current meets tissue resistance, the electrical energy is converted into thermal energy via molecular agitation or ohmic heating (direct heating). This heat could cause denaturation of vessels and blood coagulation. Thus, cauterization of the needle tracts is considered to prevent intraperitoneal bleeding through the injured vessels. Laeseke et al. [22] reported that biopsy sites after ablation had significantly less blood loss than did control biopsy sites using porcine liver or kidney. However, the volume of blood loss was very low, at less than 3 g, in the ablation group and control group from their data. Therefore, it could be expected that a RFA needle laparotomy technique could decrease nonarterial bleeding from the liver after a needle biopsy. Regardless of the procedure of hemostasis, nonarterial bleeding will stop in time without clinical problems.

In this study, no significant differences were observed in the incidence of iatrogenic bleeding between the nonablation group and the ablation group. Without needle tract cauterization, hemostasis can be achieved in several ways: (1) closure of the electrode puncture wound, (2) vascular spasm and (3) blood clotting or coagulation. Perihepatic bleeding might occur with disorders of these steps even in patients with tract ablation. It is considered from our results that needle tract cauterization does not contribute directly to hemostasis. Thus, intraperitoneal hemorrhage appeared to be equivalent regardless of non-tract ablation following RFA.

The 10 patients with peritoneal hemorrhage were classified as Child-Pugh grade A, while many Child-Pugh B/C patients were included in this study. Intraperitoneal hemorrhage is usually related to mechanical injuries caused by the RF electrode traversing a vessel or thermal injuries sustained during ablation [15, 16]. The incidence of bleeding was thus not necessarily related to liver dys-

function, low levels of the platelets or the prothrombin time. However, our results showed a high incidence of bleeding among hemodialysis patients. Bleeding is common for patients with chronic renal failure, and is caused by the following: (1) increased capillary fragility, (2) disturbance of blood coagulation and (3) administration of heparin during dialysis. Therefore, we have to perform RFA carefully in hemodialysis patients. However, further studies are needed to clarify whether the iatrogenic hemorrhage could be prevented by needle tract cauterization following RFA in hemodialysis patients.

Our study was limited by its retrospective and nonrandomized design, leading to possible inaccurate or incomplete data collection, which may result in an underestimation of complications. The nonrandomized retrospective

design is also known to be associated with possible selection case bias.

In conclusion, iatrogenic bleeding after RFA could contribute to several complicated situations including elevated blood pressure, the condition of injured arteries (branching vessel level, depth from the liver surface, capillary fragility), or past history of disease (chronic renal failure, chronic liver disease). Irrespective of needle tract cauterization following RFA, iatrogenic hemorrhage appeared to be equivalent in this population.

Disclosure Statement

The authors have no conflicts of interest to declare.

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