CLINICAL STUDY

Efficacy and Safety of Radiofrequency Ablation for Focal Hepatic Lesions Adjacent to Gallbladder: Reconfiguration of the Ablation Zone through Probe Relocation and Ablation Time Reduction

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ABSTRACT

Purpose: To evaluate the safety and efficacy of radiofrequency (RF) ablation for treatment of focal hepatic lesions adjacent to the gallbladder with electrode relocation and ablation time reduction.

Materials and Methods: Thirty-nine patients who underwent RF ablation for focal hepatic lesions adjacent to the gallbladder (≤ 10 mm) were evaluated retrospectively from January 2011 to December 2014 (30 men and 9 women; age range, 51–85 y; mean age, 65 y). Of 36 patients with hepatocellular carcinoma, 3 had a second treatment for recurrence (mean tumor size, 15 mm ± 6). Patients were divided into 2 subgroups based on lesion distance from the gallbladder: nonabutting (> 5 mm; n = 19) and abutting (≤ 5 mm; n = 20). Electrodes were inserted parallel to the gallbladder through the center of a tumor in the nonabutting group and through the center of the expected ablation zone between a 5-mm safety zone on the liver side and the gallbladder in the abutting group. Ablation time was decreased in proportion to the transverse diameter of the expected ablation zone.

Results: Technical success and technical effectiveness rates were 89.7% and 97.4%, respectively, with no significant differences between groups ($P = 1.00$). Local tumor progression was observed in 3 patients (1 in the nonabutting group and 2 in the abutting group; $P = 1.00$). There were no major complications. The gallbladder was thickened in 10 patients, with no significant difference between groups ($P = .72$). Biloma occurred in 1 patient in the nonabutting group.

Conclusions: RF ablation with electrode relocation and reduction of ablation time can be a safe and effective treatment for focal hepatic lesions adjacent to the gallbladder.

ABBREVIATIONS

HCC = hepatocellular carcinoma, LTP = local tumor progression, PEI = percutaneous ethanol injection, RF = radiofrequency

The gallbladder is at risk for potential thermal damage; complications such as perforation or cholecystitis can develop after radiofrequency (RF) ablation (1). Although surgical resection is the best curative treatment option for liver tumors, most patients are not eligible at the time of diagnosis as a result of cirrhosis or multiple lesions (2). Therefore, locoregional therapy with thermal ablation is the only alternative treatment option for the majority of patients with hepatocellular carcinoma (HCC) (3), and attempts have been made to use RF ablation for focal hepatic lesions near the gallbladder (4).

Since Chopra et al (5) first reported that percutaneous RF ablation was a feasible and safe procedure for the treatment

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of hepatic tumors located adjacent to the gallbladder, few studies have reported similar effectiveness and safety of this procedure (4,6,7). However, the treatment of focal hepatic lesions adjacent to the gallbladder is challenging because the operator must balance the risk of incomplete necrosis with the risk of collateral thermal damage to the gallbladder, including cholecystitis and perforation (1). The presence of adhesions caused by previous surgery or percutaneous therapy may be a potential risk factor for injury to the gallbladder (8). In a study in a pig model, Lee et al (9) reported that hepatic RF ablation abutting the gallbladder can produce substantial thermal injury to the gallbladder wall, including perforation, especially when performed without maintaining a safe distance. The purpose of the present study was to evaluate the safety and therapeutic efficacy of RF ablation for the treatment of focal hepatic lesions adjacent to the gallbladder with electrode relocation and reduction of ablation time.

MATERIALS AND METHODS

Study Population and Selection

The institutional review board approved this retrospective study of patients' medical and imaging records. From January 2011 to December 2014, 1,889 patients underwent RF ablation of 2,866 focal hepatic lesions at our institution with the use of ultrasound (US; n = 2,786) or computed tomography (CT) guidance (n = 80). Patients were included if the lesion was less than 10 mm from the gallbladder. Patients were excluded if they had less than 6 months of follow-up CT scans, Child–Pugh class C disease, or vascular invasion. Thirty-nine of the 1,889 patients were included in the study: 3 with metastases from the rectum and 36 with HCC. The patient population included 30 men and 9 women (age range, 51–85 y; mean age, 65 y). Of the 36 patients with HCC, 3 underwent a second treatment for recurrence. The maximum diameter of tumors ranged from 4 mm to 35 mm (mean, 15 mm ± 6 [standard deviation]) based on planning US. Thirty-one tumors were located in liver segment V, and 8 were located in liver segment VIII. The distance between the tumor and the gallbladder ranged from 0 mm to 9.9 mm (mean, 4.8 mm ± 2.8). The mean follow-up period was 24.6 months ± 13.3. Ablation times ranged from 5 minutes to 12 minutes (mean, 10.3 min; Table 1). The patients were divided into 2 subgroups based on the distance of the lesion from the gallbladder on axial CT scans: a nonabutting group (n = 19) with a distance of greater than 5 mm from the tumor margin to the gallbladder and an abutting group (n = 20) with a distance of 5 mm or less from the tumor margin to the gallbladder; the recommended safety margin is at least 5 mm. The patients' baseline and tumor characteristics are summarized in Table 1.

Induction of Artificial Ascites

To avoid thermal injury to the gallbladder, artificial ascites was created by introducing a 5% dextrose aqueous solution between the gallbladder margin and liver edge. The procedure was performed under US guidance and local anesthesia with 2% lidocaine with the use of a 6-F Angiosheath (Terumo, Tokyo, Japan) and Seldinger technique. Creation of artificial ascites was performed in 8 patients in the nonabutting group and 16 patients in the abutting group. Because the space between the gallbladder and liver edge is variable, the degree of isolation of the gallbladder with artificial ascites was not sufficient to push the gallbladder by 4 mm in the abutting group. However, ablation was still performed with circulating chilled 5% dextrose aqueous solution.

Table 1. Baseline Patient and Tumor Characteristics

Characteristic	Nonabutting (n = 19)	Abutting (n = 20)	*P* Value
Age (y)	66 ± 2	64 ± 2	.73
Distance (mm)	7.2 ± 1.6	2.6 ± 1.2	< .001
Index tumor size (mm)	12 ± 6	17.5 ± 6	.005
Artificial ascites insertion	9/19	16/20	.048
Ablation time (min)	11.4 ± 1.2	9.2 ± 2.0	< .001
IC electrode	18/19	15/20	.18
ICW electrode	1/19	5/20	

IC = internally cooled; ICW = internally cooled wet.

Ablation Procedure

RF ablation was performed percutaneously under US guidance, with local anesthesia and conscious sedation with midazolam hydrochloride achieved by one of three radiologists (P.N.K., 13 y of experience in RF ablation procedures; Y.M.S., 9 y of experience with RF ablation procedures; or H.J.W., 7 y of experience in RF ablation procedures). An ablation probe was selected based on the long diameter of the tumor; a 17-gauge internally cooled wet electrode (Cooled Wet Tip [RF Medical, Seoul, Korea]; n = 6) or a 17-gauge internally cooled electrode (Cool-tip [Covidien, Dublin, Ireland]; n = 20; or Proteus [STARmed, Goyang, Korea]; n = 13) were used. The internally cooled wet electrode was used in cases involving tumors larger than 2 cm or with broad attachment to the hepatic capsule depending on the preference of the specialist. A 200-W generator emitted RF current set to deliver maximum power with the use of the instrument's automatic impedance control. An electrode was inserted parallel to the gallbladder in all patients. In the nonabutting group, the electrode was usually inserted at the center of the tumor to achieve an adequate safety margin with 12 minutes of ablation time. In the abutting group, the probe was inserted through the center of the desired ablation zone to include the tumor, with a 5-mm safety margin on the liver side to avoid thermal injury of the gallbladder (Fig 1). The ablation time was reduced in proportion to the transverse diameter of the expected ablation zone to make an oval-shaped ablation zone (Table 2). Patients were discharged from the hospital the day after the procedure if no complication was detected on follow-up CT scans performed immediately after the procedure.