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Safety Technique for Radiofrequency Ablation of Hepatocellular Carcinoma in High-Risk Locations

Takashima H[1*], Nakatani S[1], Tanaka O[2], Shimizu S[3] and Hayashi N[4]

[1]Departments of Gastroenterology, Kayashima Ikuno Hospital, Japan

[2]Departments of Radiology, Kayashima Ikuno Hospital, Japan

[3]Departments of Gastroenterology, Osaka General Hospital of WEST Japan Railway Company, Japan

[4]Departments of Radiology, Kyoto Prefectual University of Medicine, Japan

[*]Corresponding author:

Hidetaka Takashima,
Departments of Gastroenterology,
Kayashima Ikuno Hospital, Japan
E-mail.: hide0921@mve.biglobe.ne.jp

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1. Abstract

1.1 Aims: Although radiofrequency ablation (RFA) is considered a safe and minimally invasive procedure for hepatocellular carcinoma (HCC), it is sometimes associated with serious complications. In this report, we describe methods that can be used to prevent these complications.

1.2. Methods and Results: HCC is the sixth most common malignancy and the fourth leading cause of cancer-related death worldwide. Compared to surgery, RFA is less invasive, however, this depends on the tumor stage. RFA is a curative treatment option, but occasionally RFA may cause serious adverse events depending on the HCC location.

So we describe here, how RFA can be used to avoid damage to the bile duct and gallbladder, and to accurately treat lesions around the heart. All cases were single tumor and the size were less than 3cm. Tumors that exist in these three difficult areas, complications could be avoided by devising treatment.

1.3. Conclusion: Caution should be exercised regarding serious adverse events that may occur with RFA due to the HCC location.

2. Introduction

Hepatocellular Carcinoma (HCC) is the sixth most common malignancy and the fourth leading cause of cancer-related death worldwide [1]. Extensive research on systemic treatment has been conducted, and recently, novel drugs, including sorafenib, lenvatinib, regorafenib, and ramucirumab, have been proven effective in clinical trials [2-4]. Sorafenib, a multikinase inhibitor, is the first targeted agent that has been approved as first-line therapy for advanced HCC.5 In Japan, more than 60% of HCC cases are diagnosed at an early stage (Barcelona Clinic Liver Cancer stage 0 or A), which can be treated with curative therapies, such as surgical resection, local ablation, and liver transplantation.6. Radiofrequency ablation (RFA) is a safe and minimally invasive procedure in HCC. RFA was first used in Japan in 1999. Although RFA is considered a safe and minimally invasive procedure, several complications have been reported [7-17] Ding J et al. reported mortality and complication rates of 0.038 and 3.54%, respectively, across 20 centers in Japan between January 1999 and October 2010.15 Major post-RFA complications, such as hepatic failure, intraperitoneal bleeding, hepatic abscess, bile duct injury, tumor seeding, and gastrointestinal perforation, have been reported [18-20]. The estimated mortality rate ranges between 0.1%-0.5%, while the major complication rate is 2.2%-3.1% [21]. Based on these data, we confirmed that RFA may be a safe and well-tolerated treatment for HCC. However, it may cause serious adverse events depending on the HCC location. Therefore, we described how RFA can be used to avoid damage to the bile duct and gallbladder, and to accurately treat lesions around the heart.

3. RFA Methods

3.1. Lesion Near the Main Bile Duct

The Glisson's capsule extends into the liver as sheaths around the hepatic bile ducts, hepatic arteries, and portal veins. When RFA is used for HCC lesions that are adjacent to the Glisson's capsule, surrounding organs may be affected, and thereby increasing the risk of complications such, as intrahepatic bile duct dilatation, hepatic arterioportal (AP) fistula, and hepatic infarction. Most of these complications are irreversible and may negatively affect liver function and prognosis.

Wakamatsu et al. reported that complications due to RFA, such as AP fistula, intrahepatic bile duct dilatation, and hepatic infarction developed in 10.0% of patients, 8.2%, and 1.2%, respectively [22]. RFA is contraindicated for the treatment of liver tumors located <1 cm from the main biliary duct and a bilioenteric anastomosis [23]. RFA of central liver tumors is a relative contraindication because of the risk of injury to the major bile ducts; [24-26] thermal damage may occur. This is because bile juice movement in the bile duct is very slow; therefore, intrahepatic bile ducts near the tumor are prone to thermal injury. The endoscopic nasobiliary drainage (ENBD) tube is used in clinical settings to avoid bile duct damage by cooling with a chilled saline solution infusion; however, acute pancreatitis occurs sometimes, and it may be severe [27, 28]. In 2017, Xin et al. reported that transhepatic cholangial drainage with intraductal chilled saline perfusion (PTCD-ICSP) appears to be a safe and effective technique for the management of larger HCCs (>3 cm) [29].

(Figure 1(a, b)) shows HCC located near the main hepatic bile duct. The tumor was single and 2.8 cm in size, but this patient had a very high risk of thermal bile duct damage. Therefore, we placed an ENBD tube for bile duct cooling during RFA (Figure 1c). Since acute pancreatitis occurred after endoscopic retrograde cholangiopancreatography, we removed the tube. We then chose a method that could do the ablation adequately and not damage the bile ducts. We punctured the intrahepatic secondary bile duct branch with a 21G elastor needle, and the mantle was inserted into the common hepatic duct using a micro guide wire. When we performed the RFA, the outer jacket of the elastor needle was fixed and cooled by splashing chilled saline (Figure 1d).

We described this RFA method in our previous report.30 This method is safer, simpler, and associated with shorter hospital stays and lower medical costs than PTCD-ICSP and ENBD; therefore, it may be very beneficial to patients.

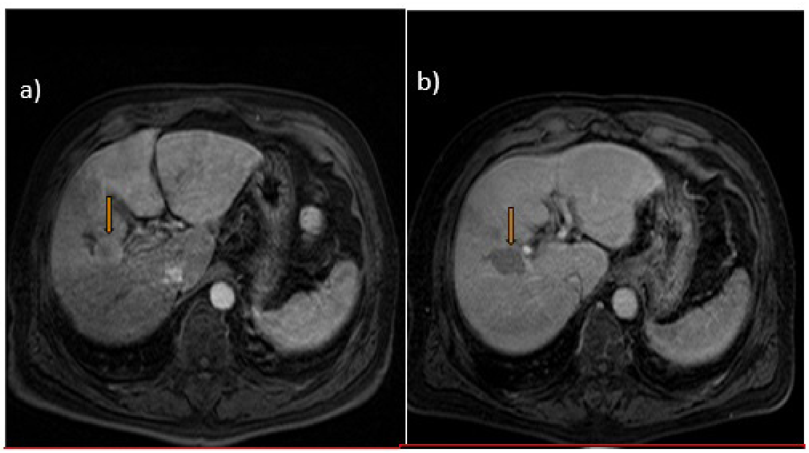

Figure 1 (a, b): In the arterial phase, the hepatocellular carcinoma was enhanced in the hilar area.

Figure 1(c): We inserted the endoscopic nasobiliary drainage tube for bile duct cooling using endscopy.

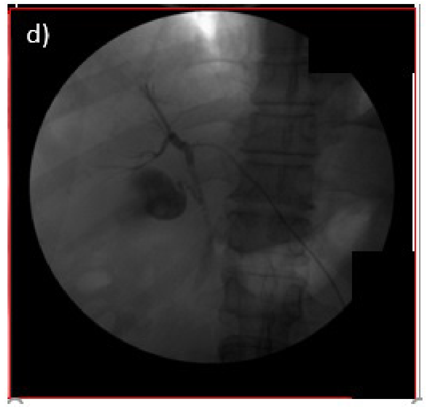

Figure 1(d): We inserted the transhepatic cholangial drainage tube for bile duct cooling under ultrasonography guidance.

3.2. Lesion Near the Gall Bladder

RFA for HCC is performed at a distance less than 1 cm to the gallbladder due to the risk of hematoma formation in the gallbladder, intralesional hemorrhage, and gallbladder perforation. Several authors suggested that percutaneous treatment can be safely used to ablate tumors close to the gallbladder, using bile aspiration and injection of sterilized solution into the gallbladder fossa to space out the tumor from the gallbladder [31], or assisted by a laparoscopic approach [32].

(Figure 2) shows a HCC in contact with the gallbladder. The tumor was single and 2cm in size. The HCC was located at a site with a great risk of RFA-related complications.

Therefore, we performed percutaneous transhepatic gallbladder aspiration with a 21G elastor needle to cool the gallbladder with a chilled saline solution infusion after aspiration bile juice. The outer jacket of the needle was fixed and flash-cooled with saline. The tumor was ablated while refluxing cold saline into the gallbladder.

After the ablation was completed, the fluid in the gallbladder was sucked as far as possible. The next day, the thickening of the gallbladder wall was observed on Computed Tomography (CT) (Figure 2 c, d); however, a successful ablation was performed, without infection, hemorrhage, and perforation. Three months later, the thickening of the gallbladder wall had disappeared on CT. There has been no recurrence for more than 3 years. Our method using the 21G elastor needle has the potential to be safer and simpler, with shorter hospital stays and lower medical costs.

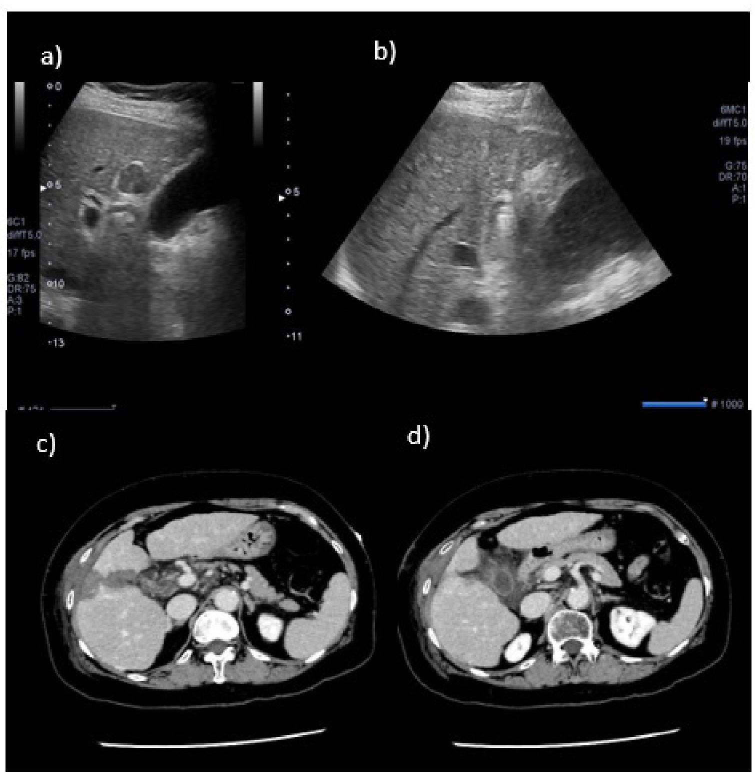

Figure 2: For the lesion near the gallbladder, we ablated the hepatocellular carcinoma under cooling conditions with a 21G elastor needle. The next day, gallbladder wall edema was observed, without any serious complications.

3.3. Lesions Near the Heart

When puncturing lesions near the heart, the deployment needle is considered safe because the needle is fixed during ablation. However, it is difficult to confirm the location of all the needle tips after deployment using ultrasonography. To resolve this problem, using the interventional radiology-computed tomography (IVR-CT) room is safe and contribute to treatment to obtain an appropriate ablated range. This is because after puncturing under ultrasound guidance, it can be fixed by deploying the RFA needle and confirming the distance to the heart by CT. Furthermore, we can determine whether it is hitting the target lesion and if it is determined that the ablation range near the heart is insufficient, we can advance the needle under combination with CT guide (Figure 3). For lesions larger than 2 cm located around the heart, we perform RFA in an IVR-CT room to detect the location of the needle tip after deployment before the start of ablation. This procedure has no associated complications, and a sufficient safety margin has been obtained in all patients who underwent this procedure.

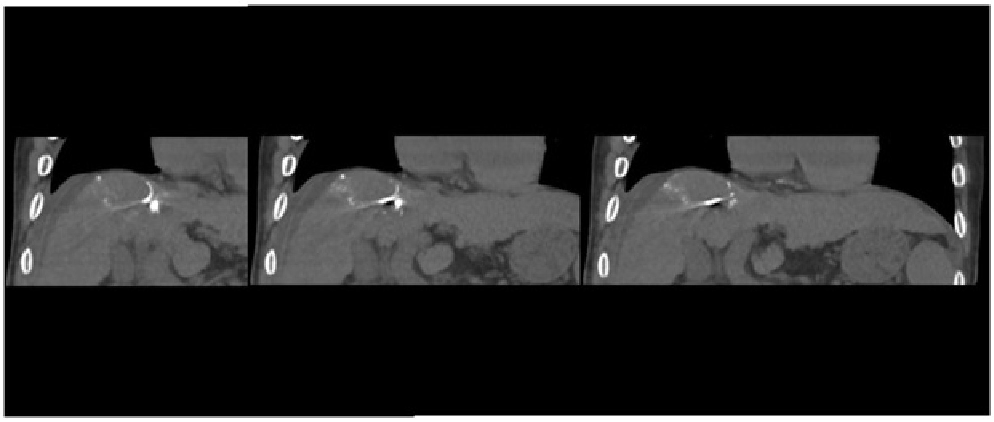

Figure 3: Under computed tomography (CT) assistance, we punctured the hepatocellular carcinoma under ultrasonography guidance. The target tumor near the heart was punctured. A needle was deployed; therefore, the needle was fixed in the liver, and the ablation range and safety were confirmed by CT imaging.

4. Discussion

RFA is the standard local treatment for HCC worldwide in patients with <3 tumors that are <3 cm in diameter [33, 34]. In the last 20 years, novel treatment methods have been established in Japan, and the disease control rate is comparable to that surgical resection <2 cm in diameter. However, some tumor locations are considered high-risk; therefore, it is important to devise means of preventing complications.

5. Conclusion

Serious adverse events may occur with RFA due to the HCC location. We must be careful to avoid complications.

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