Occurrence of Acute Hemorrhagic Cardiac Tamponade during Percutaneous Radiofrequency Ablation of Hepatocellular Carcinoma

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ABSTRACT

Percutaneous radiofrequency ablation (RFA) under image-guidance for focal hepatocellular carcinomas (HCC) is widely accepted as a safe and effective technique for local tumor control. However, serious complications can arise from percutaneous RFA. We presented a 70-year-old man who suffered a hemorrhagic cardiac tamponade, with complications occurring during radiofrequency ablation (RFA) of a hepatocellular carcinoma at the liver dome. The patient went into shock and pericardiocentesis was immediately performed. The patient was discharged uneventfully seven days later. Our case discussed the cause and management of this emergent and potentially lethal complication.

CASE REPORT

A 70-year-old man was found to have right lobe HCC in 2002. He was previously diagnosed with chronic hepatitis accompanied by more than 20 years of liver cirrhosis. Subsequently, he underwent uneventful right hepatic lobectomy. After the operation, he had abdominal ultrasound imaging exams and serum alpha fetoprotein (AFP) tests were performed at regular intervals. All imaging and tests were within normal limits until October 2012, when he was found to have an AFP level elevated to 246 ng/ml, which was significantly higher than the normal range (0-9 ng/ml). A dynamic CT liver scan was performed and revealed a 3-cm enhanced nodule in segment II of the liver (Fig. 1). Recurrent HCC was diagnosed. RFA was suggested due to the patient’s liver cirrhosis and previous right hepatic lobectomy.

At the time of treatment, the patient had Child Class A compensated liver disease. Laboratory testing revealed the following: serum albumin, 3.6 g/dl (normal range: 3.5-5.5 g/
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The patient's blood results revealed the following: dL; serum total bilirubin, 1.0 mg/dl (normal range: 0.0-1.3 mg/dL); alanine aminotransferase (ALT), 37 U/L (normal range: 0-34 U/L); aspartate aminotransferase (AST), 24 U/L (0-36 U/L); platelet count 160 x 1000/uL (normal range: 150-400 x 1000/uL), and serum alpha fetoprotein (AFP), 246 ng/mL (normal range: < 10 ng/mL).

The RFA system consisted of a generator, an active electrode and grounding pads. The RF generators had a frequency of 480 kHz and a power output of 100-200 Watts. Digital displays on the front of the device indicated the power output, impedance value and procedure time (RF3000; Boston Scientific Corporation, Boston, Massachusetts, USA). The RF electrodes used (LeVeen; Boston Scientific, Boston, Massachusetts, USA) were 14-gauge multitine expandable electrodes 15 cm in length, with a 4.0-cm array diameter when fully expanded. A two-phase impedance-based algorithm was used and the treatment was delivered for up to 15 minutes or until a major increase in impedance occurred. A second RF delivery was then performed in the same location until a new major rise in impedance occurred with 70% of the maximum power delivered. For sedation, the patient received 50 mg pethidine (Demoral®; Roche Pharmaceuticals, Basel, Switzerland) and 5 mg midazolam (Dormicum®; Roche Pharmaceuticals, Basel, Switzerland). The patient's pulse-oximetry, arterial blood pressure, and cardiac activity were monitored during the entire procedure.

During the procedure, a 4.0-cm electrode was inserted into the center of the tumor and CT guidance confirmed the deployed arrays could reach the farthest margin of the tumor (Fig. 2). Although the tumor was close to the diaphragm, there were no obverse arrays in contact with the diaphragm.

The energy level was 30 Watts at the start of ablation, and increased 10 Watts each minute until either the maximal impedance level was reached or 15 minutes elapsed. After 9 minutes of ablation, changes in the patient’s vital signs were noted and the patient lost consciousness. The patient went into shock with an increased heart rate of 140/min and decreased blood pressure of 80/50 mm Hg. Cyanosis, jugular vein engorgement and an impalpable pulse were noted. We stopped the procedure immediately and started CPR. The patient recovered after CPR and an acute pulmonary embolism was suspected.

An immediate CT scan was performed which visualized some pericardial effusions (Fig. 3). Acute cardiac tamponade was then diagnosed. Due to the patient’s unstable hemodynamic status, a cardiologist performed emergent pericardiocentesis. A 6-French pigtail was inserted into the pericardial cavity using the paraxiphoid approach; correct placement of the pigtail catheter was confirmed by ultrasound (Fig. 4). There was 80 ml of uncoagulated blood drained from the pigtail catheter. After emergent pericardiocentesis, the patient’s hemodynamic status stabilized and he was referred to the intensive care unit (ICU) for observation. Afterwards, the amount of drainage regressed and the patient was transferred to the medical ward after three days of observation in the ICU. The drainage catheter was pulled out three days later and he was discharged uneventfully.

DISCUSSION

Percutaneous RFA is commonly used as a local treatment for HCC even if the nodule is adjacent to the diaphragm or other hollow organs such as the stomach, gall bladder, and colon. Hemorrhagic cardiac tamponade is a rare complication. To our knowledge, there have been just three cases reported; only in the second case did the patient survive this sudden and fatal complication [8-10].
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There are two possible explanations for the occurrence of the percutaneous RFA-induced acute hemorrhagic cardiac tamponade. First, although the position of the electrodes was checked prior to the procedure to ensure that they were not in contact with the diaphragm, it was difficult to confidently ascertain their location. Even with real-time ultrasound or CT fluoroscopy imaging guidance, a well-experienced operator may have inadvertently placed the heated electrodes in either the diaphragm or the pericardium [8, 10]. Loh et al. reported a case where there was anterior cardiac vein injury during RFA-induced acute hemorrhagic cardiac tamponade using real-time CT fluoroscopy as guidance for electrode insertion [10]. Hence, a monopolar needle such as Cool-tip system can be more confidently positioned and monitored than a complex expandable needle. The Cool-tip system pulses RF energy to the tissue, controlling the amount of energy that could be delivered and minimizing damage to critical structures. Second, for reasons that remain unclear, the distribution of heat in vivo may be unpredictable; any structure experiencing an elevated temperature may react with an inflammatory or hemorrhagic response, as already observed in other organs such as the gall bladder and colon [6, 11, 12]. The pericardium may be severely injured by heat conduction and hemorrhage, as proposed in our case.

In order to reduce complication rates, three important strategies have been acknowledged: prevention, early detection, and proper management [5]. Prevention was the most important of the three. In our study, we noted three points related to preventive strategies. First, patients received a preprocedural assessment to identify high-risk factors for procedure complications. Patients were excluded who had coagulopathy with underlying poor hepatic reserve and tumors proximal to major structures. Second, when using RF equipment, we used a bipolar radiofrequency system that presented with many more advantages than expandable RFA probes, such as improved efficacy, no risk of skin burn or collateral damage, and decreased pain [13]. Finally, we employed protective techniques developed to thermally insulate and protect at-risk organs, such as interpositioning fluid, gas, or a balloon between the at-risk organs and the ablation zone. The additional CT images including coronal and sagittal section would give more information to confirm the position of the tip from an expandable RFA probes. Chen et al. [14] reported that injection of a 5% dextrose solution into the peritoneal cavity reduced the risk of thermal injury to the diaphragm or the bowel during RFA. Bowel protection with balloon interposition during RFA of HCC was reported by Yamakado et al. [15]. Buy et al. [16] also demonstrated that CO2 dissection is an effective technique to protect at-risk organs during RFA. Another issue in preventing complications can also be the method of approach to the lesion: specifically, the close anatomical relationship between the left lateral lobe and the heart apex. Acute hemorrhagic cardiac tamponade cannot be completely avoided in percutaneous RFA treatment for patients with left lateral lobe liver tumors, especially under non-real time CT guidance with expandable RFA probes. If RFA is considered the most advantageous treatment for liver tumors, the percutaneous approach should either be cautiously considered or even prohibited, especially with an expandable probe. Laparoscopic and open approaches may be safe because they are easier for isolating the lesions from the diaphragm. These approaches may also guarantee the use of expandable needles and the full development of...
the electrodes, which are basically needed for nodules > 30 mm in diameter to get a sufficient safely margin. Hence, the laparoscopic approach is preferred for patients without a history of abdominal surgery.

The second strategy for minimizing major complications is early detection. Although early detection cannot reduce the complication frequency, it can potentially minimize their clinical magnitude [6]. The active cooperation of patients has been noted. Performing RFA under local anesthesia and mild sedation is probably a better solution than performing under general anesthesia [17, 18]. The last key strategy is proper management of the complications. Proper management is obviously an important issue because a complication is not a static condition. Even if the complication is detected early, inappropriate management can result in mortality.

In summary, we presented a case of hemorrhagic cardiac tamponade whose occurrence could be considered as a consequence of liver RFA. It can also be a fatal complication of liver RFA. Careful consideration is required not only in selecting the best treatment modality for patients with left lateral lobe liver tumors, but also in choosing the best treatment approach. Thus, the operator should consider both effectiveness and the complication rates of each high-risk treatment modality, as was the case for our patient. Clinicians should be fully aware of all potential complications related to RFA and take preventive measures to avoid them.

REFERENCES