Clinical Case Report

Medicine®

OPEN

Transthoracic radiofrequency ablation for hepatic tumor located beneath the diaphragm under one-lung ventilation

A case report

Sung Wook Park, MD, PhD, Youngsoon Kim, MD, PhD, Hee Yong Kang, MD, PhD, Ann Hee You, MD, PhD, Jong Mi Jeon, MD, Hyunho Woo, MD, Jeong-Hyun Choi, MD, PhD*

Abstract

Rationale: Radiofrequency ablation (RFA) has become the reliable, effective, and less invasive treatment for small primary or metastatic hepatic tumors. Hepatic tumors that located immediately beneath the diaphragm are difficult to treat with percutaneous RFA due to poor visualization by percutaneous ultrasonography and the close location of the heart or lung. A transthoracic approach has been proposed to be an alternative for hepatic tumors located beneath the diaphragm that are difficult to access by conventional percutaneous or laparoscopic approaches. There has been no report regarding the anesthetic management of the transthoracic RFA for hepatic tumor.

Patient concerns: A 69-year-old female had undergone segmentectomy due to hepatocellular carcinoma 4 years ago.

Diagnoses: Newly developed hepatic tumor located in the liver dome and beneath the diaphragm was diagnosed by follow-up imaging study.

Interventions: Because the tumor could not be identified by transabdominal ultrasonography (US), transthoracic approach for RFA under one-lung ventilation was planned. General anesthesia was induced with propofol and remifentanil via target-controlled infusion system and rocuronium was administered. Orotracheal intubation with double-lumen endotracheal tube was performed and position of the tube in the trachea was confirmed by bronchoscope. The RFA electrode was introduced percutaneously into the right pleural cavity, guided by visualization through the thoracoscope and inserted into the tumor after visualizing the tumor by US. Radiofrequency waves can be successfully administered through the needle.

Outcomes: We performed successfully RFA of the hepatic tumor through one-lung ventilation and transthoracic approach. At 5 days postoperatively, she was discharged in a stable condition without any complication.

Lessons: Transthoracic RFA can be successfully performed under one-lung ventilation, optimal analgesia, and vigilant monitoring.

Abbreviations: ABGA = arterial blood gas analysis, BIS = bispectral index, BP = blood pressure, HR = heart rate, RFA = radiofrequency ablation, SPI = surgical plethysmographic index, US = ultrasonography.

Keywords: ablation, carcinoma, hepatocellular, one-lung ventilation

1. Introduction

Radiofrequency ablation (RFA) has become the reliable, effective, and less invasive treatment for small primary or metastatic hepatic tumors.[1,2] There are several approaches for RFA application. The percutaneous approach is the most common approach for RFA application and can be done under monitored anesthesia care.[3] The laparoscopic approach and laparotomy can also be used under general anesthesia.[4,5] However, hepatic tumors that located immediately beneath the diaphragm are difficult to treat with percutaneous RFA due to poor visualization by percutaneous ultrasonography (US) and the close location of the heart or lung.

A transthoracic approach has been proposed to be an alternative for hepatic tumors located beneath the diaphragm that are difficult to access by conventional percutaneous or laparoscopic approaches.[6–8] When the transthoracic approach is performed, there are some anesthetic considerations. However, there has been no report regarding the anesthetic management of the transthoracic RFA for hepatic tumor. Herein, we describe the anesthetic management of transthoracic RFA for hepatic tumor located beneath the diaphragm under one-lung ventilation.

2. Case report

A 69-year-old female (57 kg, 159 cm) was scheduled for transthoracic RFA of hepatocellular carcinoma located beneath

Editor: N/A.

The authors have no conflicts of interest to disclose.

Department of Anesthesiology and Pain Medicine, College of Medicine, Kyung Hee University, Seoul, Korea.

* Correspondence: Jeong-Hyun Choi, Department of Anesthesiology and Pain Medicine, Kyung Hee University Hospital, 23, Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Korea (e-mail: choikhang@gmail.com).

Medicine (2018) 97:51(e13863)

Received: 11 August 2018 / Received in final form: 3 December 2018 / Accepted: 5 December 2018

http://dx.doi.org/10.1097/MD.0000000000013863

the diaphragm (S8 segment). She had a history of diabetes and liver cirrhosis. She had already undergone S7 segmentectomy due to hepatocellular carcinoma 4 years ago. Newly developed hepatic tumor in the liver dome was diagnosed by follow-up imaging study (Fig. 1). Because the tumor could not be identified by transabdominal US, transthoracic approach for RFA under one-lung ventilation was planned. All laboratory tests were within normal limits.

Before the surgery, the patient had fasted for 8 hours. No premedication was administered. Noninvasive blood pressure, electrocardiogram, oxygen saturation, capnography, bispectral index (BIS) and surgical plethysmographic index (SPI) monitoring were initiated. Anesthesia was induced with propofol (2.5 μg/mL) and remifentanil (3 ng/mL) via target-controlled infusion system. After confirmation of loss of consciousness, rocuronium (0.8 mg/kg) was administered. Orotracheal intubation with double-lumen endotracheal tube was performed and position of the tube in the trachea was confirmed by bronchoscope. A 20-G vascular catheter was inserted into the right radial artery for invasive monitoring of arterial pressure and arterial blood gas analysis (ABGA) during procedure. Anesthesia was maintained with oxygen-air, propofol and remifentanil.

The patient was placed in a left-lateral decubitus position with one-lung (left lung) ventilation. Two ports for the thoracoscope (5 mm) and laparoscopic US probe (10 mm) were inserted into the pleural cavity through intercostal space (Fig. 2A). The tumor immediately under the diaphragm was identified by laparoscopic US. The RFA electrode was introduced percutaneously into the right pleural cavity, guided by visualization through the thoracoscope and inserted into the tumor after visualizing the tumor by US (Fig. 2B, C).

Radiofrequency waves were administered through the needle. When the procedure was initiated to ablate the mass, the heart rate (HR) increased from 73 beats/min to 91 beats/min, the arterial blood pressure (BP) increased from 92/54 mmHg to 147/82 mmHg, and the SPI increased from 41 to 87. Target concentration of remifentanil increased from 4 ng/ml to 7 ng/mL and then the HR and BP recovered to the previous state. BIS was maintained between 40 and 50 during the procedure. ABGA during the procedure showed no abnormalities. The procedure was performed 2 more times until the whole tumor showed highly echogenic changes to secure the 5 mm outside tumor margin. After the end of ablation, a 24-Fr chest tube was inserted through the 10-mm port site, and the remaining port site was closed. The patient was extubated with sugammadex (2 mg/kg) after the return of consciousness and adequate spontaneous ventilation. The patient was transferred to the postanesthesia care unit. A chest tube was removed on postoperative day 1. At 5 days postoperatively, she was discharged in a stable condition without any complication. There were no abnormal findings in

Figure 1. Magnetic resonance imaging scan of the hepatic tumor located beneath the diaphragm.

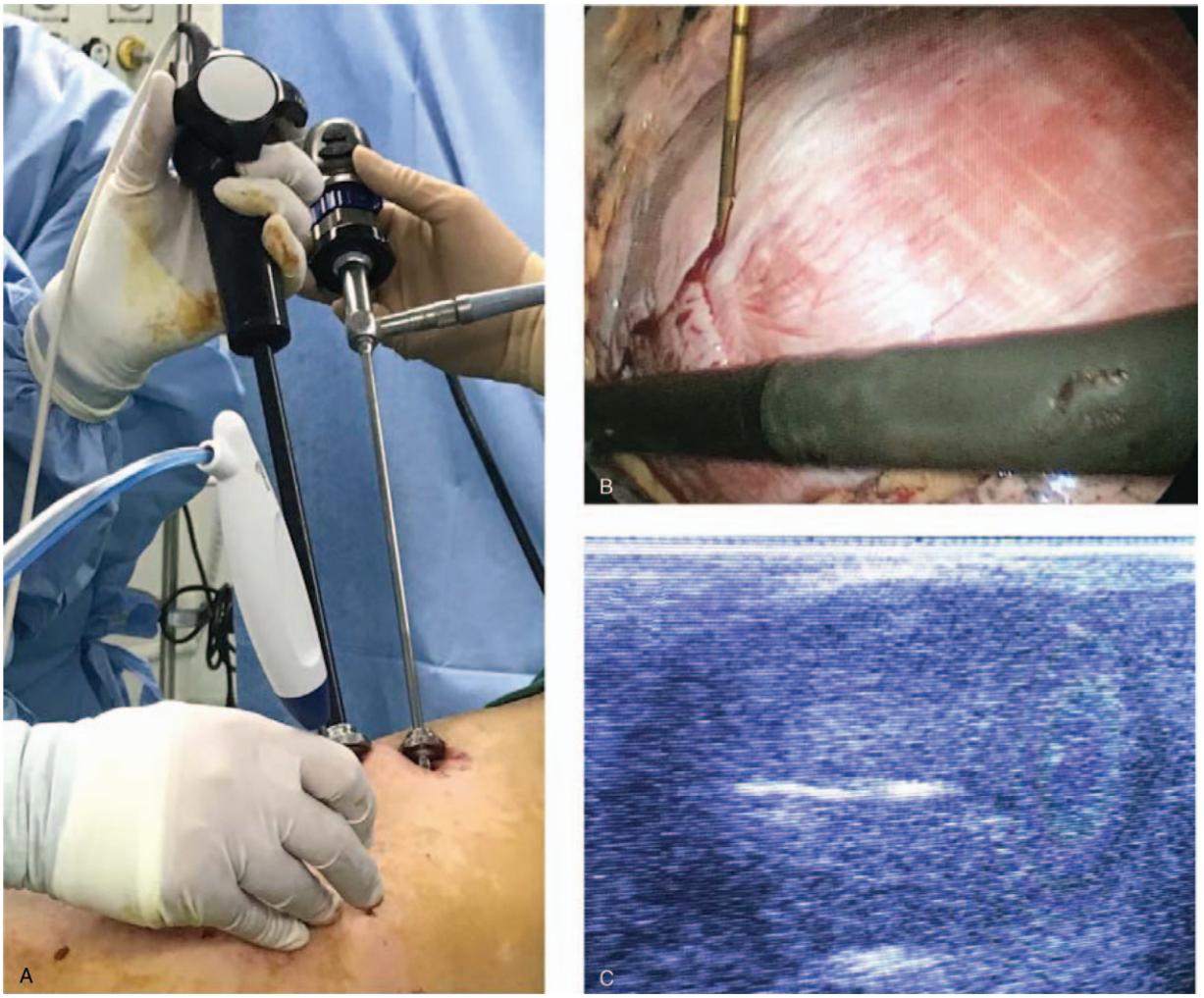

Figure 2. (A) Insertion of RFA electrode guided with thoracoscope and ultrasound, (B) Thoracoscopic view of laparoscopic ultrasound probe and RFA electrode, (C) Sonographic view of RFA electrode in the tumor. RFA = radiofrequency ablation.

the follow-up after 1 month. An informed consent for publication of the case was obtained from the patient.

3. Discussion

RFA is known to be the most effective non-surgical treatment for hepatic tumor. However, conventional approach for the hepatic tumor located just beneath the diaphragm is challenging because it is difficult to find the tumor through US and insert RFA electrodes. We performed successfully RFA of the hepatic tumor through one-lung ventilation and transthoracic approach.

There were a little reports of a transthoracic approach to RFA of hepatic tumor.[6–9] These reports suggested that thoracoscopic ablation is technically feasible and safe. Most of authors performed the procedure under one-lung ventilation. While, Lee et al suggested that one-lung ventilation usually is unnecessary, because full left lateral decubitus positioning, carbon dioxide insufflation, and the use of a lung retractor provides excellent exposure of the right hemidiaphragm.[7] However, only one out of the 3 patients that they presented had performed two-lung ventilation. Tanaka et al performed the RFA of hepatic tumor located beneath the diaphragm only with laparoscopic view in 10 patients.[10] They reported only one complication of right upper limb paralysis due to the intraoperative position. However, it was a small sample group. In addition, if the electrode passes through the thoracic cavity without observing through the thoracoscope, unintentional pneumothorax may occur.[11]

RFA can be also applied by minimally invasive laparoscopic approaches.[12] However, the laparoscopic approach has limitation to access tumor located in the liver dome. In addition, there may be a limitation of laparoscopic approach and movement of manipulation due to adhesion like this patient who has a history of previous laparotomy. Kang et al[13] reported that additional laparoscopy in the region of the thoracoscopy could provide more precise targeting of the RFA electrode to the hepatic metastatic tumor. Although this method requires further insertion of the port, transthoracic approach under one-lung ventilation and thoracoscope definitely provides better surgical fields and reduces the risk of lung injury.

Patients who receive RFA under local anesthesia usually complain of severe pain when radiofrequency waves are administered through the needle. These patients can be managed with sedatives and opioids effectively.[3] In our patient, BP, HR, and SPI increased after initiation of RFA. Although patients treated with transthoracic approach do not feel any discomfort

because of general anesthesia, analgesic drug concentration should be modulated through vital signs and SPI values during procedure. Because SPI values are known to respond to surgical nociceptive stimuli, BP and HR, as well as, SPI can be used to adjust opioids concentration.[14]

Although rare, complications related to RFA for hepatic tumors such as hydrothorax, bleeding, and cardiac arrest have been reported.[15] In order to detect the occurrence of such complications early, it is important to observe the surgical field in conjunction with changes in the vital signs. In this patient, there was little bleeding. There was no abnormality on postoperative chest X-ray. Vital signs were monitored in real time through radial artery cannulation.

However, transthoracic RFA has some limitations. If a limitation of thoracoscopic approach due to adhesion that has a history of thoracic surgery is to be expected, the benefits of using this method should be reconsidered. Also, if the patient strongly rejects general anesthesia, there will be a limit to the implementation.

In summary, we have reported on the anesthetic management of the transthoracic RFA for hepatic tumor located beneath the diaphragm with view on the need for one-lung ventilation, procedural pain, and possible complications. If there is no difficulty in one-lung ventilation, transthoracic RFA can be indicated in patients with hepatic tumors located in the liver dome that are difficult to access with conventional approach. Transthoracic RFA can be successfully performed under one-lung ventilation, optimal analgesia, and vigilant monitoring.

Author contributions

Conceptualization: Sung Wook Park, Jeong-Hyun Choi.
Data curation: Hee Yong Kang, Jong Mi Jeon.
Investigation: Hee Yong Kang, Jong Mi Jeon.
Supervision: Sung Wook Park, Jeong-Hyun Choi.
Validation: Sung Wook Park.
Visualization: Jeong-Hyun Choi.
Writing – original draft: Hee Yong Kang.
Writing – review & editing: Youngsoon Kim, Ann Hee You, Hyunho Woo, Jeong-Hyun Choi.
Jeong-Hyun Choi orcid: 0000-0003-1995-1220.

References

[1] Curley SA, Izzo F, Ellis LM, et al. Radiofrequency ablation of hepatocellular cancer in 110 patients with cirrhosis. Ann Surg 2000; 232:381–91.
[2] Solbiati L, Goldberg SN, Ierace T, et al. Hepatic metastases: percutaneous radio-frequency ablation with cooled-tip electrodes. Radiology 1997;205:367–73.
[3] Joung KW, Choi SS, Jang DM, et al. Comparative effects of dexmedetomidine and propofol on us-guided radiofrequency ablation of hepatic neoplasm under monitored anesthesia care: a randomized controlled study. Medicine 2015;94:e1349.
[4] Ido K, Isoda N, Kawamoto C, et al. Laparoscopic microwave coagulation therapy for solitary hepatocellular carcinoma performed under laparoscopic ultrasonography. Gastrointest Endosc 1997;45:415–20.
[5] Cuschieri A, Bracken J, Boni L. Initial experience with laparoscopic ultrasound-guided radiofrequency thermal ablation of hepatic tumours. Endoscopy 1999;31:318–21.
[6] Ishikawa T, Kohno T, Shibayama T, et al. Thoracoscopic thermal ablation therapy for hepatocellular carcinoma located beneath the diaphragm. Endoscopy 2001;33:697–702.
[7] Lee NN, O'Rourke RW, Cheng J, et al. Transthoracic hepatic radiofrequency ablation. Surg Endosc 2004;18:1672–4.
[8] Kurokohchi K, Hirai S, Ohgi T, et al. Thoracoscopic ethanol injection and radiofrequency ablation for the treatment of hepatocellular carcinoma located immediately under the diaphragm. Int J Oncol 2006;29:375–80.
[9] Yamashita Y, Sakai T, Maekawa T, et al. Thoracoscopic transdiaphragmatic microwave coagulation therapy for a liver tumor. Surg Endosc 1998;12:1254–8.
[10] Tanaka K, Kojima T, Hiraguchi E, et al. Laparoscopy-guided transthoracic transdiaphragmatic radiofrequency ablation for hepatic tumors located beneath the diaphragm. J Laparoendosc Adv Surg Tech Part A 2016;26:180–4.
[11] Abe E, Abe M. Pneumothorax during laparoscopic percutaneous transthoracic radiofrequency ablation for liver tumors of the hepatic dome: a case report. Masui Jpn J Anesthesiol 2007;56:1190–2.
[12] Machi J, Uchida S, Sumida K, et al. Ultrasound-guided radiofrequency thermal ablation of liver tumors: percutaneous, laparoscopic, and open surgical approaches. J Gastrointest Surg Off J Soc Surg Aliment Tract 2001;5:477–89.
[13] Kang CM, Lee KH, Kim KM, et al. Dual-scopic" intraoperative radiofrequency ablation for the treatment of a hepatic metastatic tumor located beneath the diaphragm. Surg Laparosc Endosc Percutan Tech 2008;18:202–6.
[14] Huiku M, Uutela K, van Gils M, et al. Assessment of surgical stress during general anaesthesia. Br J Anaesth 2007;98:447–55.
[15] Kong WT, Zhang WW, Qiu YD, et al. Major complications after radiofrequency ablation for liver tumors: analysis of 255 patients. World J Gastroenterol 2009;15:2651–6.