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Name of Journal: *World Journal of Clinical Cases*

Manuscript NO: 73198

Manuscript Type: CASE REPORT

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Laparoscopic repair of diaphragmatic hernia associating with radiofrequency ablation for hepatocellular carcinoma: A case report and literature review

Tsunoda J *et al.* Laparoscopic repair of diaphragmatic hernia

Abstract

BACKGROUND

Radiofrequency ablation (RFA) is an effective treatment for early-stage hepatocellular carcinoma (HCC). Although RFA is a relatively safe technique compared with surgery, several complications have been reported to be following/accompanying this treatment. Delayed diaphragmatic hernia caused by RFA is rare; however, the best surgical approach for its treatment is uncertain. We present a case of laparoscopic repair of diaphragmatic hernia due to RFA.

CASE SUMMARY

An 80-year-old woman with segment VIII HCC was treated twice in 5 years with RFA; 28 mo after the second RFA, the patient complained of right hypochondriac pain. Computed tomography revealed that the small intestine was incarcerated in the right thorax. The patient was diagnosed with diaphragmatic hernia and underwent laparoscopic repair by non-absorbable running sutures. The patient's postoperative course was favorable, and the patient was discharged on postoperative day 12. The diaphragmatic hernia has not recurred 24 mo after surgery.

CONCLUSION

Laparoscopic treatment of iatrogenic diaphragmatic hernia is effective and minimally invasive.

Key Words: Diaphragmatic hernia; Radiofrequency ablation; Hepatocellular carcinoma; Complication; Laparoscopic surgery; Case report

Tsunoda J, Nishi T, Ito T, Inaguma G, Matsuzaki T, Seki H, Yasui N, Sakata M, Shimada A, Matsumoto H. Laparoscopic repair of diaphragmatic hernia associating with radiofrequency ablation for hepatocellular carcinoma: A case report and literature review . *World J Clin Cases* 2022; In press

Core Tip: Radiofrequency ablation (RFA) is an effective treatment for hepatocellular carcinoma (HCC). Delayed diaphragmatic hernia caused by RFA is uncommon; however, the best surgical approach to its treatment has not been determined. Herein, we present a rare case of delayed-onset diaphragmatic hernia due to RFA and its treatment with laparoscopic repair. This case highlights the ultimate importance of that RFA for HCC located close to the diaphragm should be performed using artificial ascites under CT guidance to prevent an injury to the diaphragm. Laparoscopic treatment of iatrogenic diaphragmatic hernia is effective and minimally invasive.

INTRODUCTION

Hepatocellular Carcinoma (HCC) is ranked as the sixth most common neoplasm and the third leading cause of death to cancer^[1]. Surgical resection, transplantation, ablation, transarterial chemoembolization and the use of tyrosine-kinase inhibitors are treatments with proven survival benefit^[1]. Radiofrequency ablation (RFA) is an effective treatment for early-stage hepatocellular carcinoma (HCC). Although RFA is a relatively safe technique compared with surgery, several complications have been identified^[2-7]. In an analysis of 3670 patients who underwent RFA for HCC, Mulier *et al.* reported an overall complication rate of 8.9%^[3]. The major complications following RFA were abdominal

bleeding, abdominal infection, and biliary tract damage; 5 cases (0.1%) of injury to the diaphragm were also reported. Delayed diaphragmatic hernia caused by RFA is uncommon; however, the best surgical approach to its treatment has not been determined. Here, we present a case of delayed-onset diaphragmatic hernia resulting from RFA and its treatment with laparoscopic repair, along with the review of the relevant literature.

CASE PRESENTATION

Chief complaints

An 80-year-old woman had been followed up for autoimmune hepatitis-related liver cirrhosis and recurrent HCC. Colonoscopy for chronic diarrhea revealed rectal cancer, and the patient was accordingly admitted to our hospital for resection of the tumor. High anterior resection was performed. On postoperative day 10, the patient complained of right hypochondriac pain.

History of present illness

The patient had been followed up for autoimmune hepatitis-related liver cirrhosis and recurrent HCC. The patient's condition was classified as Child-Pugh Class B (7 points) with hypoalbuminemia (2.1 g/dL) without encephalopathy or ascites. Gadoxetate sodium enhanced magnetic resonance imaging (MRI) revealed masses that were highly suspicious for HCC located in the Segment VIII (S8) near the liver surface (Figure 1A). RFA was performed under ultra-sonographic guidance using an expandable needle (LeVeen™ Needle Electrode; Boston Scientific, Inc., Natick, MA, USA) 55 mo before hernia repair, with no early complications. No artificial pleural effusion or artificial ascites was used. Twenty-eight months before the hernia repair, the patient underwent repeat RFA for recurrent HCC located in S8 near the inferior vena cava (Figure 1B). Artificial pleural effusion was used during the second RFA.

History of past illness

The patient had medical histories of hypertension, hyperuricemia, heart failure, pneumonia, and laparoscopic cholecystectomy.

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Personal and family history

There was no family history of malignant tumors.

Physical examination

On her physical examination, the patient showed tenderness of the right hypochondrium without rebound tenderness, although the vital signs were normal.

Laboratory examinations

A blood test revealed normal white cell count (4800/ μ L; normal range, 3500–8000/ μ L) and c-reactive protein level (0.22 mg/dL; normal <0.30 mg/dL). It also revealed low albumin level (2.1 g/dL) and coagulopathy, including low platelet count (8.7×10^4 / μ L; normal range, $15\text{--}35 \times 10^4$ / μ L) and high international normalized ratio of prothrombin time (1.29; normal range, 0.80–1.20) due to liver cirrhosis.

Imaging examinations

A contrast-enhanced computed tomography (CT) scan revealed small intestine incarcerated in the right thorax (Figure 2). No findings suggested intestinal ischemia.

FINAL DIAGNOSIS

The final diagnosis of the presented case is diaphragmatic hernia due to RFA for HCC.

TREATMENT

The patient immediately underwent emergency surgery. The patient underwent laparoscopic hernia repair in the dorsosacral position under general anesthesia. Four trocars were inserted into the abdomen (Figure 3). The first 12-mm trocar was introduced in the left-upper abdomen using the open-entry technique so as to avoid

adhesions between the abdominal wall and visceral organs due to the previous surgery. After pneumoperitoneum by carbon dioxide insufflation, three more trocars were inserted at the right lateral abdomen, the mid-upper abdomen (12-mm trocars for operator) and near the umbilicus (a 5-mm trocar for scopist). Small intestine had slipped through the diaphragmatic defect and was observed to be incarcerated in the right thorax (Figure 4A). The small intestine was gently pulled back into the abdominal cavity using laparoscopic bowel-grasping forceps (Figure 4B). Bowel resection was not required. The hernia defect was estimated to be approximately 5 cm in diameter (Figure 4C). Intra-abdominal air pressure was reduced from 8 mmHg to 6 mmHg because the intrathoracic air pressure was increased through the defect and the pulmonary ventilation volume was decreased.

The defect was repaired using synthetic non-absorbable monofilament polypropylene sutures (3-0 PROLENE; Ethicon Inc., Somerville, NJ, USA) in the running fashion (Figure 4D). No drainage tube was placed. The operative duration was 76 min, and the estimated blood loss was <5 mL.

OUTCOME AND FOLLOW-UP

The patient's postoperative course was favorable, and the patient was discharged on postoperative day 12. The diaphragmatic hernia has not recurred 24 mo after the surgery.

DISCUSSION

Diaphragmatic hernia associated with RFA is an uncommon complication. However, diaphragmatic hernia is fatal for patients of liver cirrhosis. Therefore, it is important to recognize the risks of diaphragmatic hernia and provide prompt treatment. Twenty cases of diaphragmatic hernia due to RFA have been reported in English including our case [8-21]. The background of the patients and the details of RFA are given in Table 1. The details of diaphragmatic hernia and the treatment are presented in Table 2. The median age of the cases under study was 71 years (Interquartile range: IQR 61-79).

There were 11 (55%) males and 9 females (45%) in the current study. The most common (13 patients, 65%) cause underlying liver diseases in patients was Hepatitis C. In the present study, 16 patients (80%) had the tumor located in S8. Diaphragmatic hernia tends to occur frequently after RFA for S8 HCC, as the location of the tumor is adjacent to the diaphragm. Physical and thermal damage to the diaphragm can result in a defect in diaphragm because of poor wound healing in patients with liver cirrhosis [22].

In most cases including ours, RFA was performed under sonographic guidance. Yamagami *et al* reported that the tip of the RFA electrode is relatively difficult to detect by sonography as compared to CT while performing RFA for HCC located close to the diaphragm [12]. According to the surgical findings, the scar on the liver caused by the first RFA was close to the hernia orifice (Figure 4D), suggesting that the first RFA had caused the diaphragmatic hernia. In only 2 out of 20 cases, RFA was performed using artificial pleural effusion, while in 18 cases (90%) RFA was performed without using artificial pleural effusion or ascites. Wang *et al* have reported that the use of artificial ascites protected the abdominal wall and adjacent organs from burn injuries during RFA for HCC [23]. Clinicians and radiologists should therefore consider the use of artificial ascites during RFA to prevent diaphragmatic heat injury. Furthermore, some studies have reported that laparoscopic RFA is also useful for preventing physical injury to the diaphragm [24-26].

The median duration of time between occurrence of hernia and the previous RFA was 17 mo (IQR 12-25) in the current study. Diaphragmatic hernia is a late-onset complication of RFA. In the present case, diaphragmatic hernia occurred 28 mo after the final RFA. With the progression of liver atrophy, the space between the diaphragm and the liver enlarges, and intestines can move onto the liver, a phenomenon called *Chilaiditi syndrome* [27]. Clinicians should be aware of the possibility of the occurrence of delayed-onset diaphragmatic hernia after RFA.

Diaphragmatic hernia is a fatal disease that generally requires emergency surgery. However, 2 cases took conservative management because there were no symptoms of a strangulated hernia and they considered the risks of surgery [12, 13]. The

best surgical approach to treat diaphragmatic hernia has not been established. Liver cirrhosis is an important risk factor in surgery due to the factors, such as coagulopathy, poor nutritional status, adaptive immune dysfunction, cirrhotic cardiomyopathy, and renal and pulmonary dysfunction [28]. In 4 cases out of 20 cases, the laparoscopic approach was adopted. The laparoscopic approach is safer and more feasible than open surgery, considering the possibility of postoperative complications followed by reduced collateral circulation in the abdominal wall [16, 29]. Furthermore, the laparoscopic approach is useful for securing a field of view over the surgical site, as the location of the hernia defect is deep. However, insufficient respiratory function may preclude the laparoscopic approach because of the risks of pneumoperitoneum and pneumothorax. In our case, we reduced abdominal air pressure from 8 mmHg to 6 mmHg because thoracic air pressure increased through the hernia orifice and pulmonary ventilation volume decreased.

We repaired the diaphragmatic hernia by non-absorbable running sutures. In most cases, the hernia repair was performed by non-absorbable interrupted sutures. Regardless of the suture techniques, absorbable sutures should not be used to prevent the recurrence of hernia [30]. On the other hand, we did not use a mesh owing to the possibility of HCC recurrence, as the use of a mesh patch could preclude another RFA. However, if the diaphragmatic hernia recurs without the need for bowel resection, the use of mesh should be considered.

CONCLUSION

RFA for HCC located close to the diaphragm should be performed using artificial ascites under CT guidance to prevent an injury to the diaphragm. Clinicians should also monitor patients who have undergone RFA, staying alert to the possibility of delayed-onset diaphragmatic hernia. Laparoscopic treatment of iatrogenic diaphragmatic hernia is effective and minimally invasive.

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