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Laparoscopic repair of diaphragmatic hernia after radiofrequency ablation for hepatocellular carcinoma: Case report

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ABSTRACT

INTRODUCTION AND IMPORTANCE: We describe the case of a patients with a diaphragmatic hernia associated with radiofrequency ablation for hepatocellular carcinoma who was treated by laparoscopic repair. **CASE PRESENTATION:** An 82-years-old man with history of HCC with hepatitis C virus-related liver cirrhosis (Child-Pugh B). The patient was treated RFA to HCC for segment 4, 5, 6, 8.

After 16 months from latest RFA for segment 8, the patient was admitted to our hospital because of mild dyspnea. Computed tomography revealed a diaphragmatic herniation of bowel loops into the right thoracic cavity. The patients electively underwent laparoscopic repair of the diaphragmatic hernia. The patient was discharged from hospital without any post-operative complications.

CLINICAL DISCUSSION: The only treatment to diaphragmatic hernia is surgery, but liver cirrhosis patients limits this possibility. For the surgical treatment of patients with severe cirrhosis, the operation should be carefully assessed. We believe that a laparoscopic approach should be used for repairing diaphragmatic hernia. In the present case, we considered that a laparoscopic approach was safer and more feasible than open laparotomy.

CONCLUSION: Diaphragmatic hernia is a rare late-onset complication associated with RFA for HCC. And patients with HCC often have severe liver dysfunction and cirrhosis. A laparoscopic approach is safe and minimally invasive for sever cirrhosis patients.

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1. Introduction and importance

Radiofrequency ablation (RFA) is not commonly, but recently used technique for the treatment of unresectable primary and secondary hepatic malignancies [1].

Several reported complications associated with RFA are due to thermal damage of neighboring organs.

Even though RFA is considered to be a relative safe and a low invasive treatment for hepatocellular carcinoma (HCC), some serious complications of RFA such as hepatic abscess, perforation of the gastrointestinal wall, peritoneal dissemination, biliary-duodenal fistula, biloma, colonic fistula have been reported [2].

Mulier et al. calculated a complication rate of 8.9% and a mortality rate of 0.5%, with only cases (0.1%) of injury to the diaphragm described [3].

And Curley et al. reported a rate of early complications (within 30 days) of 7.1% and of late complications (more than 30 days after

operation) of 2.4%. But they did not describe any occurrence of injury to the diaphragm [4].

Diaphragmatic hernias are defined as congenital or acquired defects in the diaphragm and present as a protrusion of an abdominal structure into the thoracic cavity. Acquired diaphragmatic hernias are generally caused by blunt or penetrating thoraco-abdominal trauma or iatrogenic injury [5].

This is associated with symptoms of ileus, dyspnea, chest pain, pleural effusion and right shoulder pain. However, little is known about the clinical condition and the therapeutic approach of diaphragmatic hernia caused by RFA [6].

Surgical intervention is the best single treatment for the permanent cure of a diaphragmatic hernia. Among the surgical procedures, open laparotomy for diaphragmatic hernia has been widely accepted; however only 2 cases of liver cirrhosis and HCC has been reported, in which a laparoscopic approach was used to treat the diaphragmatic hernia associated with RFA treatment [7,8].

We report the case of a patients with a diaphragmatic hernia caused by RFA treatment for HCC with cirrhosis, who was successfully treated with laparoscopic surgery.

This work has been reported in line with the SCARE criteria and the related guidelines have been cited in the references [9].

Abbreviations: RFA, radiofrequency ablation; HCC, hepatocellular carcinoma; CT, computed tomography.

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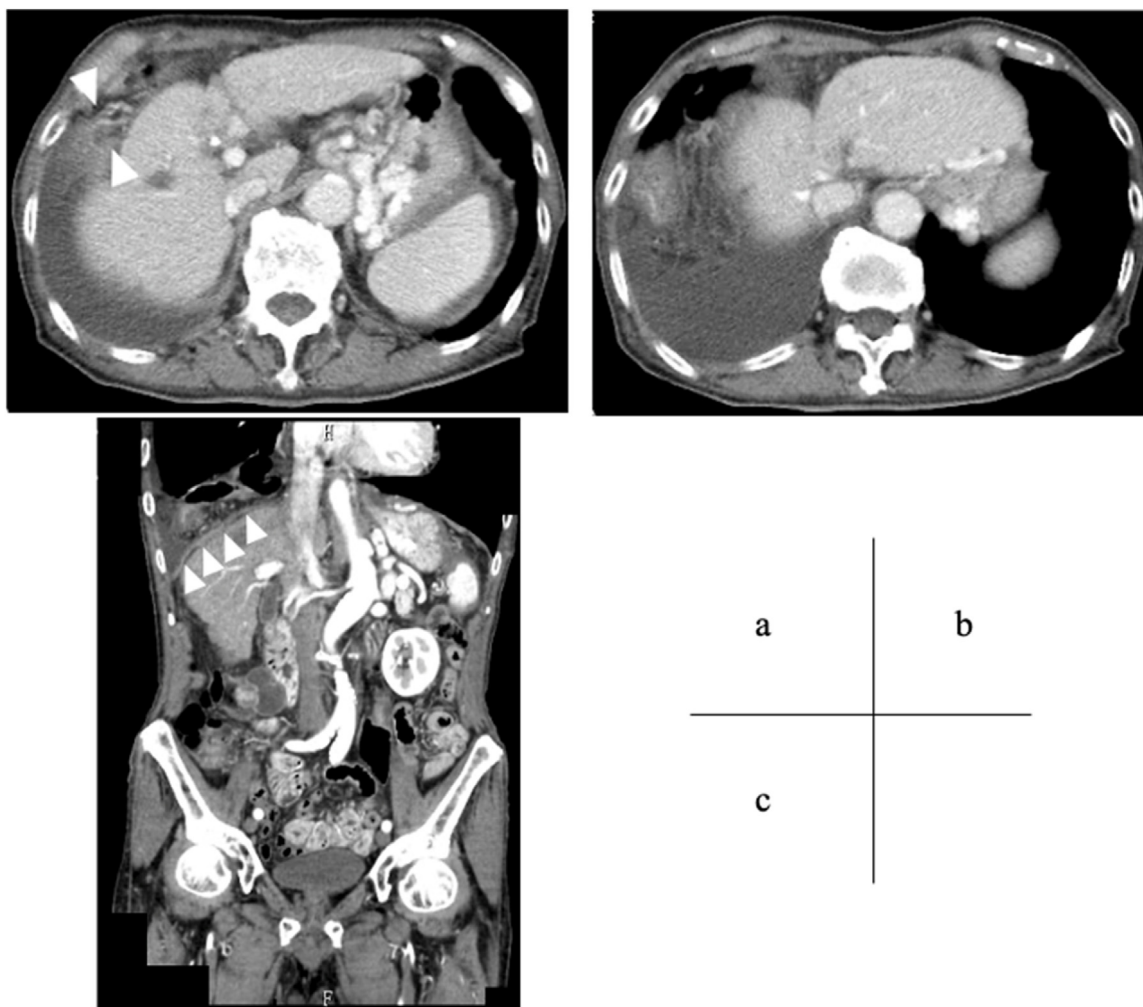


Fig. 1. Contrast-enhanced computed tomography (CT) upon admission. The transverse colon is within the right thoracic cavity. (a) Transverse CT image showing the diaphragmatic hernia. The defect in the diaphragm is between the two arrowheads. (b) Transverse CT image showing the transverse colon in the right thoracic cavity, with pleural effusion. (c) Coronal abdominal CT image showing the diaphragmatic hernia. The arrowheads are at the diaphragm.

2. Case presentation

An 82-year-old man with a history of hepatocellular carcinoma (HCC) and sigmoid colon cancer. This patient had hepatitis C virus-related liver cirrhosis (type C, Child-Pugh B criteria). The patient had undergone laparoscopic colectomy 54 months ago for cancer. And he admitted to our institution for treatment of three HCCs, in 2016, transcatheter arterial chemoembolization and RFA were first introduced for segment(S)6 HCC. And the patient underwent RFA to S4,5 in 2017 and S8 in 2019 respectively. Follow-up computed tomography scan (CT) and magnetic resonance imaging (MRI) performed. However, diaphragmatic hernia was not recognized on imaging.

The patient was admitted to our hospital with mild dyspnea, 16 months after the last RFA (S8 in 2019). The vital signs were not remarkable as follows: blood pressure, 142/85 mmHg; pulse rate, 85/ min; and SpO2, 95% (room air). Laboratory data showed C-reactive protein, 0.13; white blood cell, 8300/ul; aminotransferase, 20IU/L; and alanine aminotransferase. 40IU/L. The patient was performed CT and it was confirmed that there was a right diaphragmatic hernia. The transverse colon was found to have prolapsed into the right thoracic cavity (Fig. 1a–c). But his symptom was improved and emergency surgery was not performed. Laboratory data on admission showed normal.

We considered that repairing the hernia laparoscopically, which reduces postoperative complications in patients with severe liver cirrhosis, would be the most appropriate treatment option.

Laparoscopic surgery was performed under general anesthesia with one-lung ventilation. A 10-mm port was inserted into the umbilical and two 5-mm port were inserted (Fig. 2). Intraoperatively, the transverse colon had returned to the abdominal cavity. The size of the diaphragmatic hernia gate was 2 × 2 cm in diameter (Fig. 3). The gate was closed using 2-0 polyester suture (ETHIBOND; Ethicon Inc., Somerville, New Jersey) (Fig. 4a). The diaphragmatic vulnerable area was reinforced using 8.5 × 8.5 cm Composite mesh (Symbotex™, COVIDIEN, Mansfield, Massachusetts). And the mesh was fixed with Multifire Endo Hernia stapler (CapSure®, BARD® inc., New Jersey) (Fig. 4b). And we placed to thoracic drain from 4th intercostal space. The operation time was 101 min and the estimated blood loss was 3 mL. The operation was performed by H.U. (H.U got a Board Certified Surgeon in 2016.) The thoracic drain was removed on the 2 postoperative day and the patients was discharged on the 4 postoperative day.

The patient has no recurrence of diaphragmatic hernia at 6 months postoperative day.

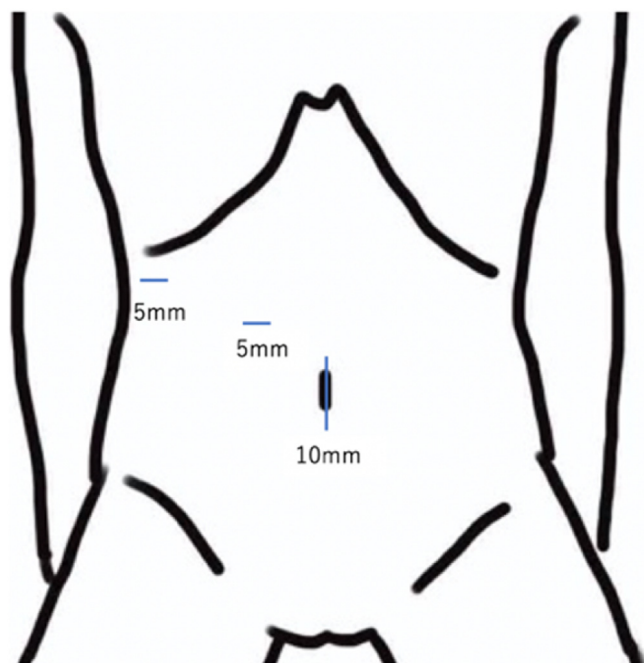


Fig. 2. Placement of the laparoscopy ports.

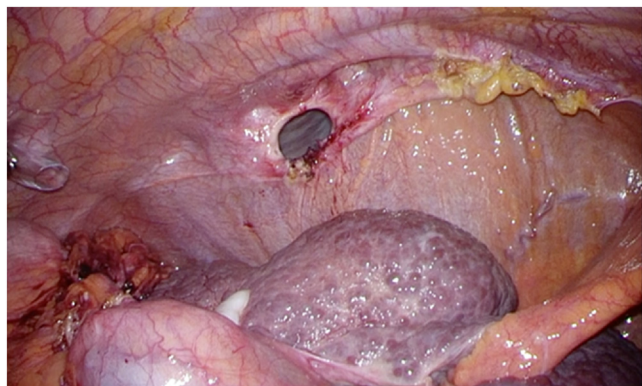


Fig. 3. The diaphragmatic hernia gate, measuring 2 cm × 2 cm.

3. Clinical discussion

Diaphragmatic hernia is a rare late-onset complication associated with RFA. RFA complications were divided into four categories as thermal damage from heating, mechanical, septic and other unexplained causes [10].

Repetitive RFA for HCC makes the diaphragm fragile due to thermal damage [9].

Thermal damage with RFA injury to nontargeted organs including the bowel, gallbladder, bile ducts, and diaphragm [11].

The thermal damage to the diaphragm may result in an inflammatory response, leading to fibrosis that could ultimately weaken the muscle fibers of the diaphragm and cause a late-onset defect [7].

Poor liver function might hinder injured tissue from healing adequately, with complications, such as ascites and pleural effusion, thereby further contributing to tissue damage [12].

Nontargeted thermal injury to the diaphragm is well described in the literature, with a prevalence of approximately 17% [11].

In the past, thirteen cases of diaphragmatic hernia associated with RFA have been reported (Table 1).

The interval between RFA and onset of diaphragmatic hernia ranged from 6 to 96 months (median: 15 months). It is indicated that diaphragmatic hernia with RFA for HCC is late-onset complication.

Among the 14 reported cases, the 10 patients have underwent RFA to S8.

This was related that the tumor location is closely relates to the risk of injury to organs adjacent to the liver due to the thermal damage caused by RFA.

Chilaiditi syndrome should remain as differential diagnosis in diaphragmatic hernia; however, CT indicated incarceration of the right colon into the thoracic cavity, which ruled out Chiraiditi syndrome.

Chilaiditi syndrome is defined as the transposition of colon between the diaphragm and liver [13].

The condition generally involves the transverse colon but can also refer to the small intestine.

Chilaiditi syndrome usually remains as an asymptomatic, anatomical variant and is normally identified as an incidental radiological finding, when it is referred to as the Chilaiditi sign.

It can occur as a direct result of abnormalities of the falciform or suspensory ligaments of the transverse colon or congenital transposition [14].

CT and X-ray are useful in diagnose of diaphragmatic hernia and especially enhance CT is an important role in the diagnosis and in determining if the intruded organs are necrotic.

All reported cases in the past also have been diagnosed by CT and X-ray.

But it is carefully that CT and X-ray are sometimes misdiagnosed as gastrointestinal perforation because the colon gas in the chest wall may be diagnosed as abdominal free air [15].

If the colon in thoracic cavity was necrosis by enhance CT, it is necessary to underdo emergency surgery.

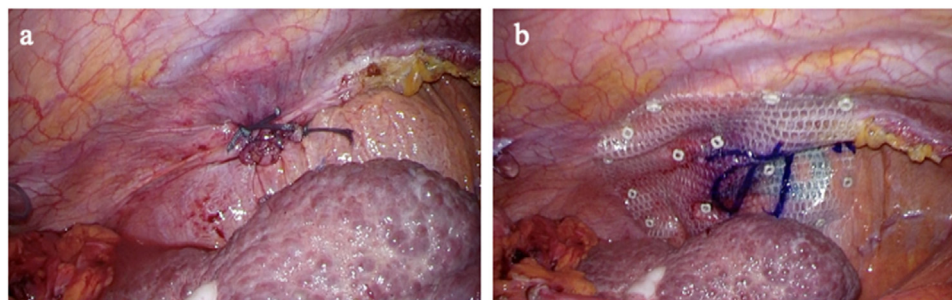


Fig. 4. The diaphragmatic hernia was repaired with sutures and mesh. (a) The hernia gate was closed with 2-0 polyester suture. (b) The vulnerable area was reinforced with 8.5 × 8.5 cm composite mesh and Endo Hernia stapler.

Table 1
Reported cases of diaphragmatic hernia following radiofrequency ablation.

No	Author/ Year	Age/ Sex	Location of HCC/ time from latest RFA (months)	Symptoms	Treatment/ Emergency or elective operation	Technical remarks Simple closure/ Reinforced by mesh	Method of diagnosis/ intestinal necrosis	Complication	Outcome	Hernia content	Recurrence of hernia	Postoperative follow up time	Remarks
1	Koda et al. (1) / 2003	61/F	S8/13	Dyspnea	OS/ elective operation	+/-	Barium enema/ Absent	HCC rupture	Dead	Large intestine	Present	Not mentioned	The patient had ileus before the surgery. Diaphragmatic hernia was observed for postoperative day 4 months. The patient recovered from the operation and was discharged from the hospital 2 weeks after admission.
2	Shibuya et al. (15) / 2006	72/M	S4, S8/18	Abdominal pain	OS/ elective operation	+/-	CT/Absent	None	Alive	Small intestine	Absent	Not mentioned	The patient was asymptomatic and, therefore, was managed conservatively. Preoperatively, this patient had abdominal pain, nausea, and vomiting. The first surgery was a simple closure. Four months later, the hernia recurred. The second surgery was a simple closure reinforced by mesh. CT was suggestive of colon necrosis. Intraoperatively, the colon was not necrotic.
3	di Francesco et al. (16) / 2008	49/M	S8/15	Abdominal pain	OS/ elective operation	+/-	CT/Absent	None	Alive	Large intestine	Absent	Not mentioned	
4	Yamagami et al. (17) / 2011	71/F	S4/9	No symptoms	Conservative therapy/-	-/-	CT/Absent	None	Alive	Large intestine	Absent	2 months	
5	Singh et al. (17) / 2011	46/F	S5, S7/11	Abdominal pain	LS/ elective operation	+/-	CT/Absent	None	Alive	Large intestine	Absent	Not mentioned	
6	Nomura et al. (8) / 2014	62/M	S8/96	Periumbilical pain	LS/ elective operation	+/ +	CT/Absent	None	Alive	Large intestine	Present	Not mentioned	
7	Abe et al. (13) / 2016	72/F	S8/15	Abdominal pain	OS/ emergency operation	+/-	CT/Present	None	Alive	Large intestine	Absent	Not mentioned	

Table 1 (Continued)

No	Author/ Year	Age/ Sex	Location of HCC/ time from latest RFA (months)	Symptoms	Treatment/ Emergency or elective operation	Technical remarks Simple closure/ Reinforced by mesh	Method of diagnosis/ intestinal necrosis	Complication	Outcome	Hernia content	Recurrence of hernia	Postoperative follow up time	Remarks
8	Nagasu et al. [3] / 2017	49/M	S4/ 17	Absent	OS/ elective operation	+/-	-/Absent	None	Alive	Absent	Absent	Not mentioned	This patient was asymptomatic and was diagnosed incidentally during surgery for recurrent HCC.
9	Nagasu et al. [3] / 2017	79/F	S8/9	Abdominal pain	OS/ elective operation	+/-	CT/Absent	None	Alive	Small intestine	Absent	Not mentioned	Even before the appearance of the diaphragmatic hernia, pleural effusion was observed in the right thoracic cavity.
10	Nagasu et al. [3] / 2017	68/M	S8/21	Abdominal pain	OS/ elective operation	+/-	CT/Absent	Liver failure	Dead	Mesenteric fat	Absent	Not mentioned	CT showed thickening of the diaphragm.
11	Nagasu et al. [3] / 2017	70/F	S6/8	Dyspnea	OS/ elective operation	+/-	CT/Absent	Liver failure	Dead	Large intestine	Absent	Not mentioned	Preoperative CT did not show necrosis of the large intestine. Intraoperatively, there was necrosis of the large intestine, which was then resected.
12	Nagasu et al. [3] / 2017	65/M	S8/16	Abdominal pain	OS/ elective operation	+/-	CT/Absent	Liver failure	Dead	Large intestine	Absent	Not mentioned	
13	Nagasu et al. [3] / 2017	76/F	S8/6	No symptoms	OS/ elective operation	+/-	-/Absent	None	Alive	Absent	Absent	Not mentioned	This case was asymptomatic and was diagnosed incidentally during surgery for recurrent HCC.
14	Our case/ 2020	82/M	S8/16	Dyspnea	LS/ elective operation	+/+	CT/Absent	None	Alive	Large intestine	Absent	6 months	Laparoscopic surgery was performed under general anesthesia with one-lung ventilation.

OS: open surgery, LS: laparoscopic surgery.

While patients reported by Abe et al. [15], underwent emergent surgical repair to correct the defect, conservative approach was followed for patients reported by Yamagami et al. [15].

Among the 14 reported cases, only Yamagami et al. [16] treated conservative and the rest authors required surgical intervention.

The only treatment to diaphragmatic hernia is surgery, but liver cirrhosis patients limits this possibility.

For the surgical treatment of patients with severe cirrhosis, the operation should be carefully assessed.

We believe that a laparoscopic approach should be used for repairing diaphragmatic hernia. In the present case, we considered that a laparoscopic approach was safer and more feasible than open laparotomy. The laparoscopic approach to diaphragmatic hernia provides a good surgical view and is easy to operate.

While the laparoscopic surgery for diaphragmatic hernia is less invasive and promotes a faster recovery in patients with stable vital signs.

Above all, accurate diagnosis and determination of the need for emergency surgery were needed for patients with diaphragmatic hernia after RFA for HCC. Because these patients have severe liver dysfunction.

4. Conclusion

In conclusion, we reported the case of laparoscopic repair for diaphragmatic hernia after RFA.

It should be note that diaphragmatic hernia occurred late-onset complication of RFA, and laparoscopic repair is safe for severe liver dysfunction patients.

Declaration of Competing Interest

The authors report no declarations of interest.

Funding

None.

Ethical approval

This case report has been performed in accordance with the Declaration of Helsinki.

Consent

We have obtained written and signed consent to publish a case report from patient.

Authors contribution

HU wrote this case reports, and JH revised the manuscript. All authors have made substantial contributions to the conception and design of the case report. HU and HK performed the surgery and postoperative management. All authors read and approved the final manuscript.

Registration of research studies

Not Applicable.

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