

# Large Diaphragm Defect Reconstruction Using Reverse Latissimus Dorsi Muscle Flap

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**Summary:** Surgical treatment of bronchobiliary fistula (BBF) is difficult. A 47-year-old woman presented with a cough with yellow yielding sputum due to BBF. The patient had the adhesion of the liver, diaphragm, and lung. We performed liver, diaphragm, and lung resections. Patient had a large defect of diaphragm. Diaphragm reconstruction was performed using a pedicled reverse latissimus dorsi muscle flap. No flap necrosis was observed. Seven months after surgery, the patient did not present yellow yielding sputum and the BBF was not observed in the computed tomography. This surgical procedure was useful for treating the diaphragm defect both safely and easily. We believe that the reverse pedicled latissimus dorsi muscle flap is a reliable alternative for large diaphragm reconstruction after severe BBF. (*Plast Reconstr Surg Glob Open* 2020;8:e3199; doi: [10.1097/GOX.0000000000003199](https://doi.org/10.1097/GOX.0000000000003199); Published online 30 November 2020.)

**B**ronchobiliary fistula (BBF) was first introduced in 1850,<sup>1</sup> but the management of BBF is still challenging and difficult.<sup>2–5</sup> Many authors reported conservative treatment using percutaneous transhepatic biliary drainage.<sup>2,3</sup> However, there is a limitation to conservative treatment.<sup>3</sup> To successfully and completely treat BBF, patients require a liver lobectomy, lung lobectomy, and resection of the diaphragm. Our patient presented with an intractable cough with yellow yielding sputum. Despite conservative treatment, a BBF existed. In our case, the BBF was caused by adhesion of the liver, diaphragm, and lung. After liver, diaphragm, and lung resections, a large defect was observed in the diaphragm. Safely reconstructing wide and deep defects requires reliable and well-vascularized tissue. We performed a diaphragm reconstruction using the reverse latissimus dorsi muscle flap. This surgical procedure was useful for treating the diaphragm defect both safely and easily.

## CASE REPORT

A 47-year-old woman presented with cough and yellow yielding sputum. When the patient was 41 years old, she had received partial hepatectomy and chemotherapy due to hepatocellular carcinoma. However, tumor recurrence was observed 3 times. The patient received partial

hepatectomy 3 times and chemotherapy twice. Despite partial hepatectomy and chemotherapy, tumor recurrence was observed again. The patient received heavy ion beam therapy twice (110.8 Gy) and radiofrequency liver ablation. After radiofrequency ablation, tumor recurrence was not observed. However, she presented with yellow yielding cough. The result of endoscopic retrograde cholangiopancreatography suggested that there was a fistula between the lower lobe of the lung and the B8 bile duct. The computed tomography showed adhesion of the S7 segment liver, diaphragm, and lower lobe lung, and a sub-diaphragm abscess was observed. The drainage of the sub-diaphragm abscess was performed by a general surgeon. Two months later, no sub-diaphragm abscess was observed, but the fistula remained between the liver and lung. Seven months after drainage, the patient underwent surgery. She was placed in semi-lateral position, and partial liver resection and diaphragm and lower-lobe lung resection were performed by general surgeons. The size of the diaphragm defect was 7 × 8 cm (Fig. 1). The right latissimus dorsi (LD) muscle flap was harvested in the same surgical position. LD muscle was detached from the humerus, and the thoracodorsal artery and vein were ligated (Fig. 2). To take a shorter path for the diaphragm, the proximal stump of the LD muscle was introduced from ninth intercostal space incision. The LD muscle was fixed to the stump of the diaphragm using a 4-0 braided nylon suture (Fig. 3). The postoperative course was uneventful. No flap necrosis, severe hemothorax, ascites, or infection was observed. Eighteen months after surgery, the patient did not show the recurrence of cough with yellow yielding sputum. The BBF was not observed in the computed tomography (Fig. 4).

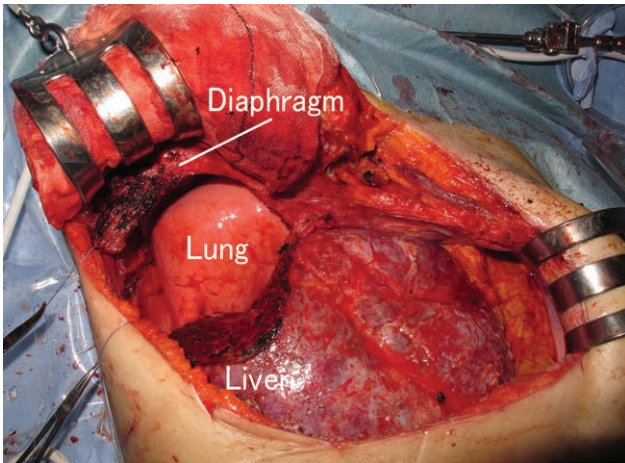
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Received for publication July 22, 2020; accepted August 31, 2020.

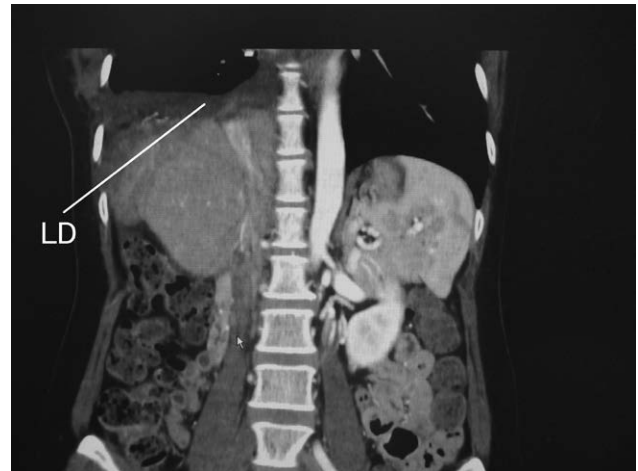
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DOI: [10.1097/GOX.0000000000003199](https://doi.org/10.1097/GOX.0000000000003199)

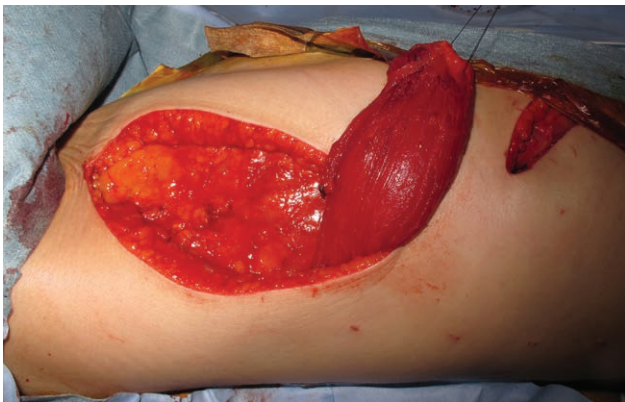
**Disclosure:** The authors have no financial interest to declare in relation to the content of this article.



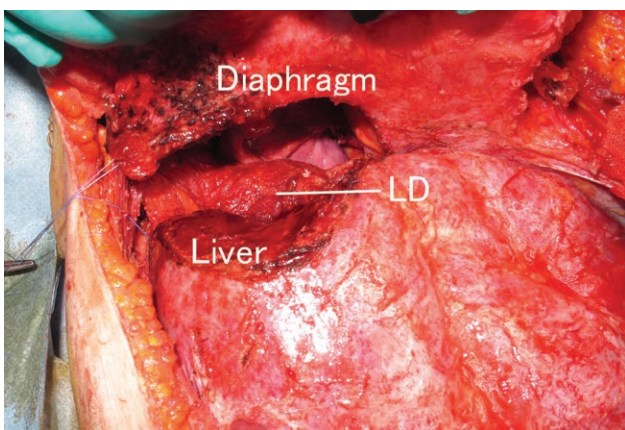
**Fig. 1.** Partial liver, diaphragm, and lower lobe lung resection was performed. The diaphragm defect was 7 × 8 cm.



**Fig. 4.** The findings of computed tomography 8 months after surgery. Lung and liver were separated by LD flap.



**Fig. 2.** The right latissimus dorsi muscle flap was harvested. The flap was detached from the humerus, and the thoracodorsal artery and vein were ligated.



**Fig. 3.** The proximal stump of the LD muscle was introduced from the ninth intercostal space incision. The flap was fixed to the stump of the diaphragm using a 4-0 braided nylon suture.

### DISCUSSION

BBF was first reported by Peacock in 1850.<sup>1</sup> BBF is an abnormal connection between the liver and lung caused

by an inflammatory reaction in the sub-diaphragmatic space with subsequent rupture into the lung. The cause of BBF is congenital or secondary.<sup>2</sup> Some authors reported experiences of BBF; however, none included large cases. Liao et al. performed a review of the literature and reported that the main cause of BBF was tumor resection, including secondary, primary, and metastases.<sup>2-5</sup> Xi et al. reviewed the literature and suggested that the wide application of radiofrequency ablation has increased the incidence of BBF. The radiofrequency ablation of the liver causes necrosis in the liver. When an abscess is close to the top of the diaphragm, inflammatory adhesion may occur between the liver and lung.<sup>4</sup> Before receiving radiofrequency ablation treatment, our patient underwent three partial hepatectomies and three heavy ion beam therapies.

The management of BBF is difficult. Many authors reported conservative treatment using percutaneous transhepatic biliary drainage.<sup>2,3</sup> However, in their report, some patients experienced BBF recurrence.<sup>3</sup> This result suggests that there is a limitation to conservative treatment. To successfully and completely treat BBF, patients require a liver lobectomy, lung lobectomy, and resection of the diaphragm. However, reconstruction of the lung, diaphragm, and liver complex defects is challenging because the diaphragm and lung complex defects are located deep inside the abdominal wall. Chua et al. performed intercostal muscle flap transfer to reconstruct the diaphragm.<sup>3</sup> In their study, the defect in the diaphragm was small (1.5 cm).<sup>3</sup> Some authors have reported diaphragm reconstruction using artificial materials.<sup>6,7</sup> Kuwahara et al. reported a successful large diaphragm reconstruction after wide resection of a soft tissue tumor at the chest wall using an artificial mesh graft.<sup>6</sup> Lee et al. performed large diaphragm reconstruction using polytetrafluoroethylene in patients with a congenital diaphragmatic defect. They also experienced cases with disproportion of the artificial diaphragm after a long-term follow-up.<sup>7</sup> Sugiyama et al. performed diaphragm reconstruction using autologous fascia for a patient who had a diaphragm hernia.<sup>8</sup> Our patient had both a large diaphragm defect and an

infection. We needed a safe and reliable reconstructive option which has well-vascularized, large-size tissue. We performed a pedicled reverse LD muscle flap transfer for diaphragm reconstruction.

The use of a reverse pedicled LD muscle flap was first introduced by Bostwick et al<sup>9</sup>. The vascular supply of a pedicled reverse LD muscle flap arose from perforators of the intercostal artery, and the major pedicles of this flap are paraspinal perforators and midscapular perforators.<sup>10–13</sup> Some authors report successful reconstruction of tumor resection in the back, lumbar, and ileal regions using turnover reverse pedicled LD flap.<sup>11–13</sup> Even though their flap only included paraspinal intercostal perforators, they could harvest a well-vascularized flap. Our flap was well-vascularized and reliable because we confirmed 2 midscapular perforators intraoperatively. This suggests our flap included both midscapular and paraspinal intercostal perforators. In our case, the patient was placed in a semi-lateral position, and the surgical position was not changed during the surgery. Our flap was not only reliable but also easy to harvest and less invasive. We believe that the pedicled reverse LD flap is a reliable alternative for large diaphragm reconstruction after severe BBF.

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