

CASE REPORT

Successful Reconstruction of Post-Hepatectomy Bile Duct Injury Using Magnetic Compression Anastomosis

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KEYWORDS

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ABSTRACT

Iatrogenic bile duct injuries (BDI) following hepatectomy represent a serious and potentially life-threatening complication. Magnetic compression anastomosis (MCA) is an emerging minimally invasive technique that can restore biliary continuity when conventional endoscopic or percutaneous methods fail. We report the case of a 68-year-old man with a history of sigmoid colon cancer and liver metastases underwent right hepatectomy with wedge resection of segment 4a. Postoperatively, he developed persistent jaundice. Imaging demonstrated left intrahepatic duct dilatation with abrupt narrowing at the hepatic confluence. Percutaneous transhepatic biliary drainage (PTBD) was established; however, guidewire cannulation via both ERCP and PTBD failed due to complete biliary obstruction. The patient subsequently underwent MCA. The magnets approximated across the stenosis, creating a neo-anastomosis. After successful biliary recanalization and stenting were achieved. At the six-month follow-up, the patient remained clinically stable with normal liver function. In conclusion, this case demonstrates the feasibility and clinical success of MCA for biliary reconstruction following iatrogenic bile duct injury post-hepatectomy. MCA offers a safe, effective, and less invasive alternative to surgical reconstruction.

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Introduction

Iatrogenic bile duct injuries (BDI) following hepatectomy represent a serious and potentially life-threatening complication, often associated with complex biliary anatomy, prior interventions, or intraoperative trauma¹⁻³. Effective management requires a multidisciplinary approach within specialized hepatobiliary centers, with treatment goals focused on controlling biliary sepsis, restoring ductal continuity, and preserving hepatic function.

Endoscopic management, including balloon dilatation and sequential stenting, is typically effective for partial or non-complex strictures. In more challenging cases, percutaneous transhepatic biliary drainage (PTBD) may serve as an adjunct or alternative. However, when complete biliary obstruction precludes guidewire passage, surgical reconstruction becomes necessary. Despite being the standard of care in such scenarios, surgery is associated with considerable morbidity and mortality, particularly in patients with altered anatomy or poor physiological reserve.

To address these limitations, magnetic compression anastomosis (MCA) has emerged as a novel, minimally invasive technique that enables internal biliary drainage by creating a neo-anastomosis through gradual pressure-induced necrosis between two magnets placed via endoscopic and percutaneous routes⁴⁻⁶.

Herein, we report a case of successful biliary tract reconstruction using MCA in a patient with iatrogenic bile duct injury following right hepatectomy, highlighting the feasibility and clinical applicability of this technique in managing complex biliary injuries.

Case report

Chief complaints

Persistent jaundice following right hepatectomy.

History of present illness

A 68-year-old man with a history of diabetes mellitus, hypertension, and coronary artery disease was initially diagnosed with sigmoid colon cancer with synchronous liver metastases. In 2022, he underwent laparoscopic sigmoidectomy and intraoperative microwave ablation of five hepatic lesions. He subsequently received adjuvant chemotherapy with oxaliplatin and capecitabine. In 2024, routine surveillance with contrast-enhanced computed tomography (CT) revealed new hepatic metastases in segments 5/6 (measuring 3.7 cm) and segment 4 (1.5 cm), while the previously ablated sites remained stable. The patient subsequently underwent a right hepatectomy with wedge resection of segment 4a. During the right

hepatectomy, the right hepatic duct was identified and divided at the hilum using suture ligation with Vicryl 3-0. Special care was taken to avoid the left hepatic duct; however, the hilar dissection was challenging due to adhesions from previous microwave ablation.

On postoperative day 3, the patient developed clinically apparent and persistent obstructive jaundice, indicative of an acute post-surgical injury rather than a delayed fibrotic stricture. Laboratory investigations confirmed the obstruction, showing elevated levels of total bilirubin (TB) at 11.0 mg/dL, direct bilirubin (DB) at 10.2 mg/dL, and alkaline phosphatase (ALP) at 297 IU/L. Follow-up computed tomography (CT) imaging

revealed postoperative changes consistent with a prior right hepatectomy. Notably, there was marked dilatation of the left intrahepatic bile ducts, with an abrupt cutoff at the hepatic duct confluence, indicative of high-grade biliary obstruction (Figure 1). A percutaneous transhepatic biliary drainage (PTBD) catheter was inserted into the left intrahepatic duct; however, guidewire cannulation of the distal bile duct via the PTBD tract was unsuccessful. Subsequent percutaneous transhepatic cholangiography (PTC) demonstrated significant dilatation of the left intrahepatic bile ducts with complete obstruction at the level of the hepatic duct confluence (Figure 2).



Figure 1 Axial contrast-enhanced CT showing left intrahepatic duct dilatation with abrupt cutoff at the hepatic duct confluence following right hepatectomy



Figure 2 Percutaneous transhepatic cholangiography shows dilated left intrahepatic ducts with complete obstruction at the hepatic duct confluence

Physical examination

The initial assessment indicated that the patient's vital signs were within normal limits. He appeared clinically stable, though visible jaundice was noted. Cardiopulmonary examination revealed no abnormalities.

Abdominal examination demonstrated a well-healed surgical scar consistent with previous laparoscopic

sigmoidectomy and right hepatectomy. A percutaneous transhepatic biliary drainage (PTBD) catheter was observed exiting through the right upper quadrant of the abdominal wall. The abdomen was flat and soft, with no tenderness, guarding, or signs of peritoneal irritation. No shifting dullness was detected.

Treatment

Subsequent endoscopic retrograde cholangiopancreatography (ERCP) was performed in an attempt to traverse the biliary stricture with a guidewire, but the procedure was unsuccessful due to complete obstruction at the level of the biliary confluence. Cholangiographic imaging revealed a biliary stricture with an estimated gap of approximately 1 mm. Given the failure of standard ERCP-guided stenting and the inability to access the proximal duct, the multidisciplinary team elected to proceed with magnetic compression anastomosis (MCA) as an alternative method to restore biliary continuity.

In preparation for MCA, the existing percutaneous transhepatic biliary drainage (PTBD) tract was gradually dilated to 10 French over 1–2 weeks to facilitate the insertion of the magnet. This step was essential to ensure smooth insertion and passage of the magnet through the established entry tract during the procedure. Custom-made, gold-plated neodymium magnets measuring 3 mm in diameter were used. The magnet delivery system utilized a 10-French stent pusher, which was modified by creating a hole at its tip using a surgical blade to allow guidewire cannulation (Figure 3).



Figure 3 Magnet delivery system. The daughter magnet is delivered via PTBD and the parent magnet via ERCP. A side hole on the pusher (black arrow) allows guidewire cannulation

A parent magnet was delivered endoscopically through a side-viewing duodenoscope and positioned distal to the site of obstruction, just proximal to the ampulla of Vater. Simultaneously, a daughter magnet was inserted percutaneously via the left-sided PTBD tract and

advanced under fluoroscopic guidance to the proximal end of the obstruction within the left intrahepatic duct. Under continuous fluoroscopic monitoring, magnetic attraction brought the two magnets into alignment across the fibrotic segment (Figure 4).

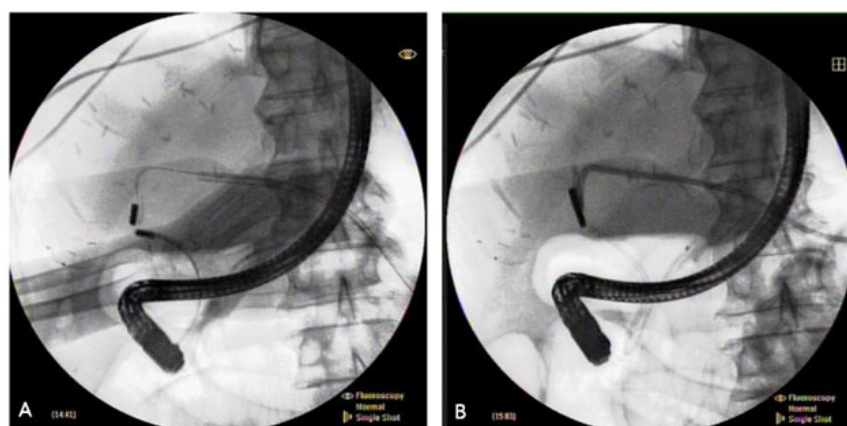


Figure 4 Fluoroscopic cholangiogram showing (A) Parent and daughter magnets positioned via ERCP and PTBD. (B) Magnet alignment across the stricture, enabling fistula formation

This configuration allowed for the gradual compression of the intervening fibrotic tissue between the magnets, facilitating necrosis and the eventual formation of a neo-anastomosis. During this period, external biliary drainage was maintained via the PTBD catheter to prevent bile accumulation.

Three weeks after magnet placement, both magnets passed spontaneously into the gastrointestinal tract and were expelled without incident. Following this, a guidewire was successfully advanced through the newly formed tract, confirming the establishment of a continuous channel (Figure 5A). The tract was then dilated using a standard biliary dilator, and an internal plastic stent was deployed via ERCP to maintain patency of the reconstructed duct.

Outcome and follow up

Following successful internal drainage and stent placement, the percutaneous transhepatic biliary drainage (PTBD) catheter was removed. The patient's clinical status improved markedly, with progressive resolution of jaundice.

One month after stent placement, laboratory investigations demonstrated a significant reduction in cholestatic parameters, with total bilirubin decreasing to 1.61 mg/dL and direct bilirubin to 1.29 mg/dL. At the three-month follow-up, endoscopic retrograde cholangiopancreatography (ERCP) was performed, and the internal plastic stent was replaced with a fully covered self-expandable metal stent (FCSEMS) to ensure long-term ductal patency (Figure 5B). At six months, the patient remained clinically stable, with normal liver function tests and no radiologic or clinical evidence of recurrent biliary obstruction.

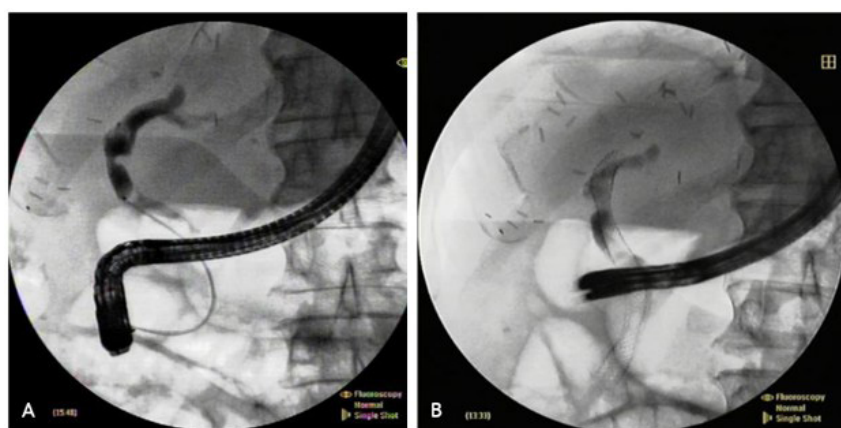


Figure 5 Fluoroscopic cholangiogram showing (A) Successful ductal recanalization 3 weeks post-MCA. (B) A fully covered self-expandable metal stent (FCSEMS) placement

Discussion

Iatrogenic bile duct injuries (BDI) following hepatectomy have been reported in 3.6% to 17% of cases¹⁻³. These injuries, particularly when involving complete transection or severe strictures, pose considerable management challenges. When endoscopic approaches such as stenting fail, surgical biliary reconstruction remains the standard of care. However, this intervention is associated with significant morbidity and mortality, with reported complication rates ranging from 16% to as high as 39%, especially in patients with complex biliary anatomy or multiple comorbidities^{1,2}.

Magnetic compression anastomosis (MCA) has emerged as a promising minimally invasive alternative for patients with refractory biliary strictures⁴⁻⁶. The technique involves placing magnets at both ends of the occluded duct to induce pressure necrosis and form a neo-anastomosis. MCA has been most commonly reported in biliary strictures following liver transplantation or cholecystectomy⁵⁻¹⁷. The application of MCA in BDI after hepatectomy remains relatively underreported¹⁸⁻²⁰. The present case adds to this limited body of evidence and supports MCA as a feasible and effective alternative in this subgroup.

The literature indicates that MCA achieves technical success in 70% to 100% of cases, with durable long-term patency⁵⁻¹⁹. Compared to surgical reconstruction, MCA has demonstrated benefits including reduced complication rates, shorter hospital stays, and avoidance of reoperation, particularly in elderly or high-risk patients^{13,21}.

One of the key factors influencing the success of magnetic compression anastomosis (MCA) is the inter-ductal distance between the proximal and distal bile ducts. Comprehensive preprocedural imaging using MRCP, ERCP, or percutaneous transhepatic cholangiography is crucial for assessing anatomical feasibility and ensuring appropriate case selection^{13,21}.

The surgical technique used during the initial hepatectomy can significantly influence the success of MCA. In this case, the use of suture ligation near the biliary confluence likely resulted in a complete, short-segment occlusion (approximately 1 mm), which is ideal for magnetic attraction¹¹. Furthermore, the timing of MCA intervention is critical. We initiated the procedure two weeks after the injury. Addressing the stricture in the subacute phase, after the initial postoperative inflammatory response had subsided yet before dense chronic fibrosis could develop, likely facilitated easier magnet alignment and more rapid fistula formation compared to long-standing chronic strictures¹¹.

The efficacy of magnetic coupling diminishes significantly when the inter-ductal distance exceeds 10–15 mm⁵⁻¹⁹. Nonetheless, technical innovations, such as serial magnet alignment, have extended this limit to up to 20 mm in selected cases¹². In our case, favorable ductal alignment and a short stricture length facilitated successful magnet approximation and fistula formation.

Recanalization time is highly variable, influenced by multiple factors including stricture length, ductal shape, magnetic force, alignment pattern of the magnets, and the anatomical axis of the bile duct.¹⁰⁻¹³ The reported duration in the literature ranges from 2 to 50 days⁵⁻¹⁹. The researchers opted for a 3-week interval, as supported by previous studies⁸, though follow-up imaging revealed earlier recanalization. This observation underscores the need for further research to better predict optimal recanalization timing and guide follow-up protocols.

For long-term outcomes, MCA appears to outperform conventional ERCP-based treatments. Li et al. reported a recurrence rate of 3.9% post-MCA, substantially lower than the 3–37.5% range seen with ERCP. This may be attributed to MCA's mechanism of action, which mimics surgical resection by inducing ischemic necrosis of the stricture, potentially lowering restenosis risk¹³. To maintain fistula patency, most authors recommend stent placement for 6–12 months post-recanalization, using either plastic or fully covered self-expandable metal stents (FCSEMS)^{10,11,13}. Nonetheless, optimal stenting duration is yet to be defined.

When conventional ERCP fail, endoscopic ultrasound guided hepatogastrostomy (EUS-HGS) is a common alternative^{20,22,23}. Although direct comparative studies are lacking for rare bile duct injuries following hepatectomy, MCA offers a distinct anatomical advantage. While the ultrasound guided bypass provides effective drainage, it requires permanent stenting and bypasses the sphincter of Oddi. Furthermore, a recent meta regression analysis highlights adverse events for this bypass, including cholangitis, sepsis, bleeding, biliary leakage, pneumoperitoneum, and stent migration²². In contrast, MCA creates a neo anastomosis that restores natural physiological biliary continuity, making it preferable for a physiological long-term reconstruction. Notably, current clinical trends suggest that EUS-HGS is increasingly utilized as a preferred access route to deliver magnets instead of PTBD, thereby eliminating the need for an external drainage catheter and improving patient comfort^{20,23}.

Although promising, MCA is not without risks. Misalignment, magnet migration, or inadequate tissue necrosis may result in failed fistula formation, false lumen creation, bile leakage, or retained magnets within the intrahepatic bile ducts^{5,6,15}. Some reports have described cases of cholangitis and biliary bleeding due to entrapment of blood vessels between the magnets^{13,21}. Furthermore, the technique requires close interdisciplinary collaboration among interventional radiologists, endoscopists, and hepatobiliary surgeons, underscoring the importance of institutional experience and the availability of specialized expertise to ensure procedural success and minimize risks.

Conclusions

In conclusion, this case reinforces MCA as a valuable salvage technique for complex post-hepatectomy biliary injuries. When performed in appropriate candidates with careful anatomical evaluation and coordinated multidisciplinary

care, MCA offers a less invasive yet effective alternative to surgical reconstruction.

Ethical statement

Written informed consent for publication was obtained from the patient on 4 September 2025, and all identifying information was anonymized to protect patient confidentiality.

References

1. Tan L, Liu F, Liu ZL, et al. Meta-analysis of risk factors for bile leakage after hepatectomy without biliary reconstruction. *Front Surg* 2021;8:764211. doi:10.3389/fsurg.2021.764211.
2. Boonstra EA, de Boer MT, Sieders E, et al. Risk factors for central bile duct injury complicating partial liver resection. *Br J Surg* 2012;99(2):256-62. doi:10.1002/bjs.7802.
3. Xue S, Wang H, Chen X, et al. Risk factors of postoperative bile leakage after liver resection: A systematic review and meta-analysis. *Cancer Med* 2023;12(14):14922-36. doi:10.1002/cam4.6128.
4. Yamanouchi E, Kawaguchi H, Endo I, et al. A new interventional method: Magnetic compression anastomosis with rare-earth magnets. *Cardiovasc Intervent Radiol* 1998;22:S155.
5. Itoi T, Yamanouchi E, Ikeuchi N, et al. Magnetic compression duct-to-duct anastomosis for biliary obstruction in a patient with living donor liver transplantation. *Gut Liver* 2010;4(Suppl 1):S96-8. doi:10.5009/gnl.2010.4.S1.S96.
6. Itoi T, Kasuya K, Sofuni A, et al. Magnetic compression anastomosis for biliary obstruction: Review and experience at Tokyo Medical University Hospital. *J Hepatobiliary Pancreat Sci* 2011;18(3):357-65. doi:10.1007/s00534-010-0350-9.
7. Chavan R, Solanki R, Patel M, et al. Magnetic compression anastomosis of post-cholecystectomy benign biliary stricture using modified accessories (with video). *Indian J Gastroenterol* 2024;43(5):1068-71. doi:10.1007/s12664-024-01613-2.
8. Eurboonyanun C, Eurboonyanun K, Wongwiwatchai J, et al. Magnetic compression anastomosis for post-cholecystectomy biliary stricture. *Diagn Interv Endosc* 2023;2(2):50-3. doi:10.5152/DiagnIntervEndosc.2023.23073.
9. Do MY, Jang SI, Cho JH, et al. Magnetic compression anastomosis for treatment of biliary stricture after cholecystectomy. *VideoGIE* 2022;7(7):253-5. doi:10.1016/j.vgie.2022.03.005.
10. Jang SI, Do MY, Lee SY, et al. Magnetic compression anastomosis for the treatment of complete biliary obstruction after cholecystectomy. *Gastrointest Endosc* 2024;100(6):1053-60.e4. doi:10.1016/j.gie.2024.05.009.
11. Jang SI, Cho JH, Lee DK. Magnetic compression anastomosis for the treatment of post-transplant biliary stricture. *Clin Endosc* 2020;53(3):266-75. doi:10.5946/ce.2020.095.
12. Garg P, Sharma M. Magnetic compression anastomosis for treatment of post-cholecystectomy bile duct injury related biliary strictures. *J Clin Interv Radiol ISVIR* 2024;9(1)40-6. doi:10.1055/s-0044-1795157.

13. Li Y, Sun H, Yan X, et al. Magnetic compression anastomosis for the treatment of benign biliary strictures: A clinical study from China. *Surg Endosc* 2020;34(6):2541-50. doi:10.1007/s00464-019-07063-8.
14. Nakaseko Y, Shiba H, Yamanouchi E, et al., editors. Successful treatment of stricture of duct-to-duct biliary anastomosis after living-donor liver transplantation of the left lobe: A case report. *Transplantation Proceedings*; 2017: Elsevier.
15. Unal E, Ciftci TT, Akinci D, et al. Magnets in action: Role of interventional radiologists in magnetic compression anastomosis procedures. *Insights Imaging* 2024;15(1):128. doi:10.1186/s13244-024-01705-9.
16. Unal E, Esen U, Uysal A, et al. Combined endoscopic-percutaneous approach for magnetic compression anastomosis in post-transplant anastomotic biliary strictures. *Eur Radiol* 2025;35(10):6598-607. doi:10.1007/s00330-025-11634-w.
17. Odemis B, Baspinar B, Tola M, et al. Magnetic compression anastomosis is a good treatment option for patients with completely obstructed benign biliary strictures: A case series study. *Dig Dis Sci* 2022;67(10):4906-18. doi:10.1007/s10620-022-07381-3.
18. Kobori I, Noro T, Takada M, et al. Recanalization by magnetic compression anastomosis for complete bile duct obstruction and retrieval of a migrated magnet. *Endoscopy* 2023;55(S 01):E993-5. doi:10.1055/a-2134-7324.
19. J Jiang XM, Yamamoto K, Tsuchiya T, et al. Magnetic compression anastomosis for biliary obstruction after partial hepatectomy. *Endoscopy* 2018;50(6):E144-5. doi:10.1055/a-0588-4653.
20. Sritunyarat Y, Ratanachu-Ek T, Attasaranya S, et al. Magnetic compression anastomosis via EUS-guided hepaticogastrostomy for recanalization of complete common hepatic bile duct transection. *VideoGIE* 2021;6(8):365-7. doi:10.1016/j.vgie.2021.05.003.
21. Zhang G, Liang Z, Zhao G, et al. Endoscopic application of magnetic compression anastomosis: A review. *J Gastroenterol Hepatol* 2024;39(7):1256-66. doi:10.1111/jgh.16574.
22. Binda C, Dajti E, Giuffrida P, et al. Efficacy and safety of endoscopic ultrasound-guided hepaticogastrostomy: A meta-regression analysis. *Endoscopy* 2024;56(9):694-705. doi:10.1055/a-2282-3350.
23. Caz M, Busatto A, Truebano V, et al. Biliary recanalization with magnets in a liver transplant patient via combined ERCP and EUS-guided hepaticogastrostomy. *Endoscopy* 2025;57(S 02):S635. doi:10.1055/s-0045-1806657.