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CASE REPORT

Transarterial and Transvenous Approach for the Embolization of Arteriovenous Fistula between the Hepatic Arteries and Inferior Vena Cava Associated with Liver Abscess Due to Cholangitis

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Abstract:
An 87-year-old woman was hospitalized for liver abscesses and cholangitis due to common bile duct stones. She developed worsening anemia and abdominal pain. Contrast-enhanced computed tomography revealed an intrahepatic pseudoaneurysm and an arteriovenous fistula between the hepatic arteries and inferior vena cava. The initial endovascular treatment was transarterial embolization. The pseudoaneurysm was embolized with an N-butyl-2-cyanoacrylate mixture, and the inflow arteries of the arteriovenous fistula were embolized with microcoils. However, the residual perfusion of the arteriovenous fistula remained. A second endovascular treatment was performed using the transarterial and transvenous approaches. The inflow arteries were embolized using microcoils and gelatin sponges and the dominant outflow vein was embolized using microcoils, resulting in the disappearance of the perfusion in the arteriovenous fistula.

Keywords:
cholangitis, liver abscess, arteriovenous fistula, transvenous embolization, transarterial embolization

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Introduction

Severe cholangitis and liver abscess may damage vasculature. However, an arteriovenous fistula (AVF) between the hepatic arteries and inferior vena cava (IVC) is exceptionally rare, and its treatment strategy remains unclear. We report a case of liver abscess due to cholangitis with an AVF between the hepatic arteries and IVC treated with transarterial and transvenous embolization.

Case Report

An 87-year-old woman without diabetes mellitus was hospitalized for liver abscesses and cholangitis due to common bile duct stones. The patient had a medical history of total gastrectomy and splenectomy for gastric cancer. Percutaneous transhepatic gallbladder drainage and biliary stenting were performed, and antibiotics were administered. Bile cultures were positive for *Klebsiella oxytoca*, *Escherichia coli*, *Enterococcus casseliflavus*, and *Enterococcus gallinarum*. Blood cultures were positive for *Escherichia coli*, *Enterococcus casseliflavus*, and *Enterococcus gallinarum*. Twenty-three days after admission, the patient developed worsening anemia and abdominal pain. Contrast-enhanced computed tomography (CECT) revealed a pseudoaneurysm and an AVF, which were not observed on the previous CECT, associated with the hepatic abscess (**Fig. 1a, b**, and Supplementary Video 1). Therefore, emergent transarterial embolization was performed.

A 5-F sheath (Radifocus Introducer IIH; Terumo, Tokyo, Japan) was inserted into the right femoral artery. Celiac angiography was performed using a 5-F Cobra catheter (Ha-

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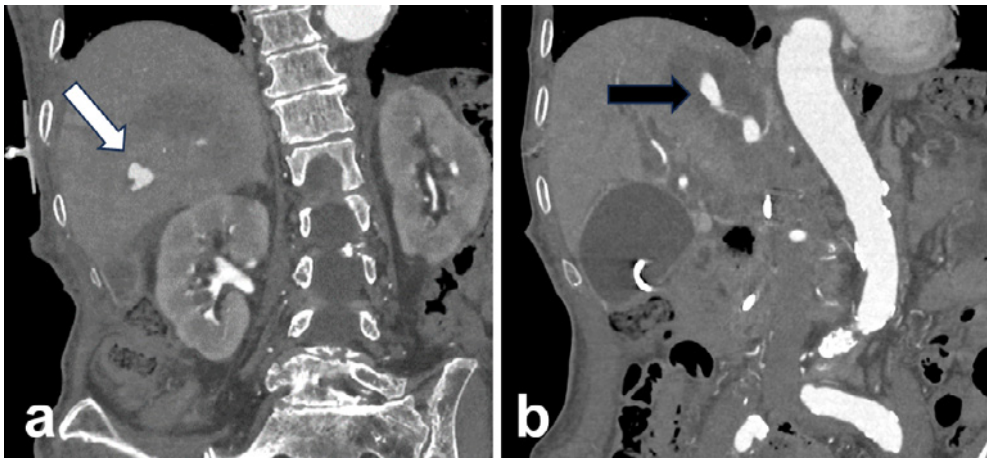

Figure 1. Coronal contrast-enhanced computed tomography showed the pseudoaneurysm (a: white arrow) and arteriovenous fistula (b: black arrow). Supplementary Video 1 shows the sequential computed tomography images.

nako Medical Co., Ltd., Saitama, Japan), revealing a pseudoaneurysm and an AVF in the liver (**Fig. 2a**). The hepatic arteries were approached using a triple coaxial catheter system consisting of a guiding catheter, a 2.7-F tip microcatheter (BISHOP HF; PIOLAX, Kanagawa, Japan), and a 1.9-F tip microcatheter (Carry Leon; UTM, Aichi, Japan) with a 0.014-in guidewire (Meister S14; Asahi Intecc, Aichi, Japan). The anterior superior segmental artery of the right hepatic artery (A8) (**Fig. 2b**) and medial segmental artery of the left hepatic artery (A4) (**Fig. 2c**) branches were identified as the major inflow arteries of the AVF. Branch A8 was embolized using two detachable microcoils: one Ruby coil (COMPLEX SOFT, 4 mm × 15 cm, Penumbra, Alameda, CA, USA) and one i-ED coil (COMPLEX Infini, 3 mm × 10 cm, KANEKA Medix, Japan). The Ruby coil was inserted through the 2.7-F tip microcatheter after the removal of the 1.9-F selective microcatheter. Branch A4 was embolized using one detachable microcoil: i-ED coil (COMPLEX SilkySoft, 2 mm × 8 cm, KANEKA Medix). The pseudoaneurysm of the right anterior inferior segmental artery (A5) was embolized using N-butyl-2-cyanoacrylate (NBCA) (Histoacryl; B. Braun, Melsungen, Germany) mixed with iodized oil (Lipiodol; Guerbet, Villepinte, France) at a ratio of 1:4 (NBCA:Lipiodol) (**Fig. 2d**). Intrahepatic hemorrhage was controlled. However, celiac angiography revealed a small amount of residual blood flow in the AVF (**Fig. 2e**). Because embolization of multiple small inflow arteries was deemed too complex using emergent transarterial embolization, the initial treatment was discontinued.

A follow-up CT one week after the first endovascular treatment showed a residual AVF (**Fig. 3**). Therefore, a second endovascular treatment was performed the day after the follow-up CT (8 days after the first treatment). A 5-F sheath (Radifocus Introducer IIH; Terumo) was inserted into the right femoral artery. Right inferior phrenic angiography was performed using a 5-F shepherd hook catheter (Hanako Medical Co., Ltd.), revealing an inferior phrenic artery blood supply to the AVF (**Fig. 4a**). The right inferior phrenic artery was catheterized using a 2.6-F tip microcatheter (Carry Leon; UTM) and a 0.014-in guidewire (Meister S 14; Asahi Intecc) and embolized using a 1-mm cut gelatin sponge (Serescue, Astellas Pharma, Tokyo, Japan). Celiac angiography revealed a residual AVF (**Fig. 4b**). The hepatic artery was subsequently catheterized using a guiding catheter and a microcatheter. Branch A8 (**Fig. 4c**), which was the artery responsible for AVF development, was additionally embolized using one i-ED coil (COMPLEX SilkySoft, 2 mm × 3 cm, KANEKA Medix) (**Fig. 4d**). However, selective angiography of the right and left hepatic arteries revealed multiple inflow sources in both arteries (**Fig. 4e, f**). Therefore, transvenous embolization was planned. A 5-F sheath (Radifocus Introducer IIH, Terumo) was inserted into the right femoral vein. The drainer vein flowing into the IVC was catheterized using a 5-F Mikaelsson catheter (Hanako Medical Co., Ltd.). The shunt point was approached using a triple coaxial catheter system consisting of a guiding catheter, a 2.6-F tip microcatheter (Carry Leon; UTM), and a 1.5-F tip microcatheter (Carry Leon; UTM) with a 0.014-in guidewire (Meister S14; Asahi Intecc) and a 0.010-in guidewire (ASAHI CHIKAI 10; Asahi Intecc) (**Fig. 4g**). The shunt was embolized using five detachable microcoils: four Target XL (Stryker, Kalamazoo, MI, USA) (5 mm × 15 cm [two coils], 5 mm × 10 cm [one coil], and 4 mm × 12 cm [one coil]) and one Penumbra POD packing coil (Penumbra, USA) (60 cm). The POD packing coil was inserted through the 2.6-F tip microcatheter after the removal of the 1.5-F tip microcatheter. Postembolization celiac angiography revealed the disappearance of the AVF (**Fig. 4h**). Follow-up CECT 1 week after the second endovascular treatment showed no AVF recanalization or complications, such as hepatic infarction. Two weeks after the second endovascular treatment, the percutaneous transhepatic gallbladder drainage tube was removed. Antibiotics were continued for 5 weeks after the second endovascular treatment, allowing for the successful treatment of cholangitis and liver abscess. Follow-up CECT 3 months after the second endovascular treatment also showed no AVF recanalization.

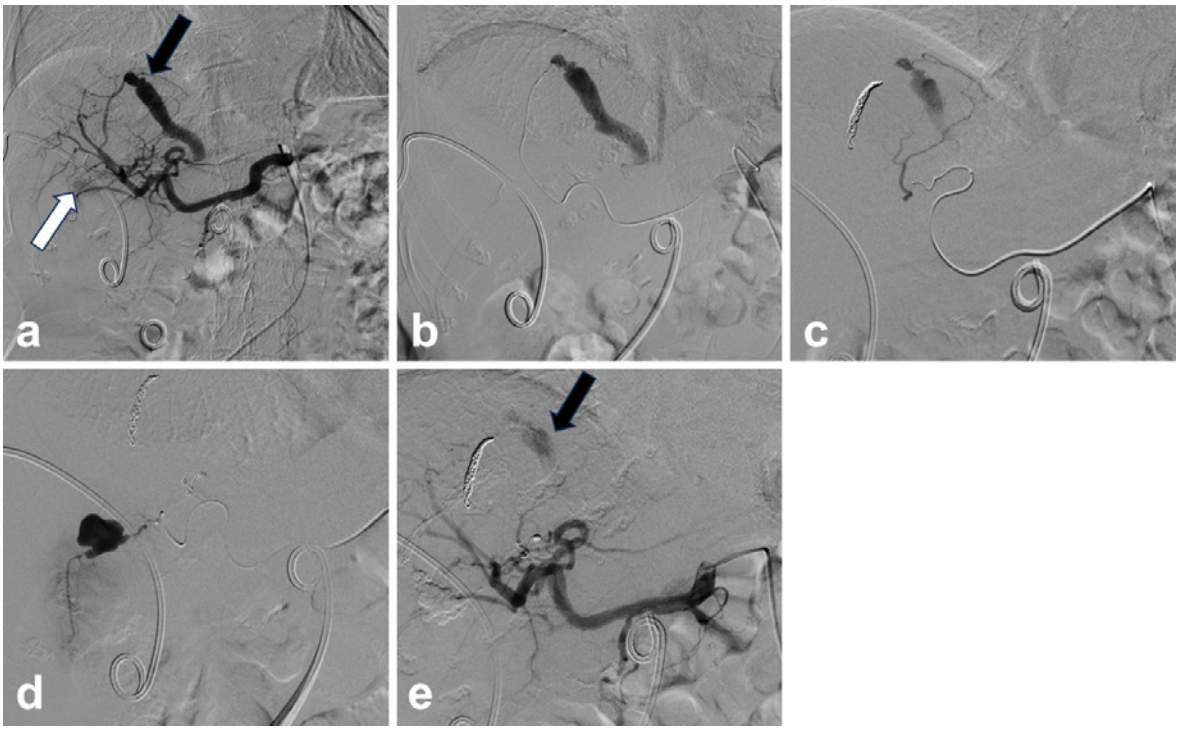

Figure 2. Celiac angiography showed the pseudoaneurysm (a: white arrow) and arteriovenous fistula (a: black arrow). The A8 (b) and A4 (c) hepatic artery branches, which were the arteries responsible for the AVF, were embolized using detachable microcoils. Using an N-butyl-2-cyanoacrylate and Lipiodol mixture, the pseudoaneurysm was embolized (d). Celiac angiography after embolization showed residual shunt blood flow (e: black arrow).

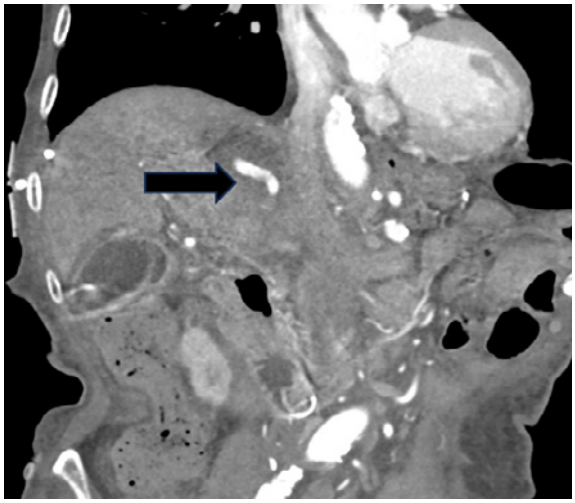

Figure 3. Coronal contrast-enhanced computed tomography showed a residual arteriovenous fistula (black arrow).

Discussion

We treated the AVF between the hepatic arteries and IVC, which was associated with liver abscess, with transarterial and transvenous embolization. Hepatic abscesses associated with cholangitis are common. However, AVF formation is a previously unreported and exceedingly rare complication.

Although the mechanism of AVF formation in this case remains unclear, pseudoaneurysms have been associated with liver abscesses [1, 2]. Hepatic abscesses rarely involve the portal vein or hepatic vein and cause thrombus formation. However, several reports have indicated that liver abscesses caused by amoeba or Klebsiella pneumoniae more frequently involve the portal vein and hepatic vein [3-5]. In our case, we posit that a pseudoaneurysm caused by the liver abscess might have ruptured into the right hepatic vein or that the liver abscess invaded both the intrahepatic artery and right hepatic vein, resulting in an AVF. Specifically, the bile and blood cultures in the present case did not yield growth of amoeba or *Klebsiella pneumoniae*, which are highly invasive to the vein, and thus, the rupture of a pseudoaneurysm was particularly likely responsible for the AVF development. With a secondary AVF, as in the present case, the risks of bleeding and high-output heart failure may be important indications for radical treatment.

In this case, the AVF featured multiple inflows from the hepatic arteries and a dominant outflow vein contiguous with the IVC. According to the classification by Cho et al., this was a type II arteriovenous malformation, and embolization using a transvenous approach was an appropriate technique [6]. The transarterial approach alone may be insufficient to embolize multiple inflow arteries because shunt flow may remain, as in the present case. Transarterial embolization, notably employing microcoil intervention, may lead to proximal embolization and suboptimal attenuation of arterial hemodynamic flux [7]. On the contrary, liquid embolic materials such as NBCA and particle embolic materials such as gelatin sponges may cause complications due to the migration of the embolic material into the venous circulation. In our case, the AVF disappeared after performing transvenous embolization using microcoils, reducing the risk

Figure 4. Right inferior phrenic angiography showed a residual arteriovenous fistula (a: black arrows). The right inferior phrenic artery was catheterized using a microcatheter and embolized using a 1-mm cut gelatin sponge. Celiac angiography showed a residual arteriovenous fistula (b). The A8 hepatic artery branch, which was the artery responsible for the AVF, was embolized with a microcoil (c, d). The right hepatic artery (e) and the left hepatic artery (f) revealed multiple inflow arteries. We approached the shunt point of the arteriovenous fistula using a transvenous triple coaxial catheter system (g). The dominant outflow vein was coil embolized, and celiac angiography showed loss of shunt flow (h).

of embolizing all inflow arteries of the AVF. However, bacterial adherence to the coils is a concern, which is regarded as a complication of coil embolization. This may result in increased difficulty in controlling local infections at the treatment site. However, coil infections are only sparsely reported [8], for which the necessity of therapeutic interventions for its prevention remains undetermined. In addition, even if bacteria adhered to the coils, there was a high likelihood that the causative bacteria were the same as those responsible for liver abscesses. Therefore, while adhering to the standard treatment using antibiotics that were sensitive to the causative organisms of liver abscesses, if difficulties were encountered during the course of treatment, it may have been prudent to consider the possibility of coil infection. Detailed examinations should be performed. Furthermore, if necessary, prolonged administration of antibiotics, local drainage, or surgical excision of the coils may be required.

Herein, we report a case of an AVF between the hepatic arteries and IVC in a patient with cholangitis and liver abscesses. Combined transarterial inflow embolization and transvenous outflow embolization may be effective in the endovascular treatment of an AVF.

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