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INTERVENTIONAL RADIOLOGY

TECHNICAL NOTE

Iatrogenic arterio-biliary fistula and peripheral hepatic artery pseudoaneurysm after transjugular liver biopsy: complication management using a microvascular plug

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ABSTRACT

This study aimed to report on complication management in a 58-year-old woman referred for transjugular biopsy for the evaluation of unknown liver disease. After an initial uneventful biopsy procedure, the patient complained of severe upper abdominal pain. Laboratory tests revealed increasing liver enzymes. Imaging studies depicted an iatrogenic pseudoaneurysm associated with an arterio-biliary fistula originating from the right peripheral hepatic artery. Angiography and percutaneous transarterial superselective embolotherapy was performed by means of a microcatheter and microvascular plug. Precise device positioning allowed for successful closure of the bleeding site without compromising the hepatic vasculature.

Transjugular liver biopsy (TJLB) is a safe, fast, and effective procedure for the sampling of liver tissue for a definitive histologic and virologic differentiation of a variety of liver diseases.[1] Especially, in the case of liver-associated bleeding disorders, TJLB reduces the procedure-associated bleeding risk because the biopsy specimen is acquired through the hepatic vein, resulting in drainage of any associated hemorrhage into the vessel lumen. In contrast to the percutaneous transabdominal route, there is no liver capsule passage.[2] Minimally invasive endovascular embolotherapy is an established treatment option for traumatic lesions of visceral arteries including pseudoaneurysms.[3]

Technique

A 58-year-old female patient (height: 159 cm and weight: 68 kg) with asymptomatic icterus was hospitalized for diagnostic workup of an unknown hepatopathy with elevated liver enzymes (initial gamma-glutamyltransferase, GGT, 312 U/L). At admission, her lab test verified increased GGT levels up to 543 U/L, while alanine aminotransferase (52 U/L) and aspartate aminotransferase (44 U/L) were only moderately elevated. Her total serum bilirubin level (1.0 mg/dL), coagulation parameters, and other routine laboratory parameters were within normal limits. Transient elastography (FibroScan®) revealed liver tissue stiffness of 21.8 kPa, indicating an advanced stage of liver fibrosis. Magnetic resonance cholangiopancreatography demonstrated "beading" of the bile ducts inside the right liver lobe caused by alternating strictures and dilating up to 10 mm, while further diagnosis was inconsistent with primary sclerosing cholangitis. Liver-specific antibody testing including antinuclear antibodies, anti-neutrophil cytoplasmic antibodies, antimitochondrial antibodies (AMA-M2), and hepatitis serology was negative, and there was no history of chronic inflammatory bowel disease. After interdisciplinary evaluation and patient's written informed consent, TJLB was performed by a standard technique using an 18 G biopsy needle (Transjugular liver access and biopsy set LABS-100-J). Four liver tissue cylinders were circumferentially sampled along the central liver vein without periprocedural signs of potential complications.

On the next day, the patient complained of increasing upper abdominal pain. The initial ultrasound examination was unremarkable. Due to persisting severe pain and increasing serum bilirubin levels up to 5.8 mg/dL on the second day, contrast-enhanced abdominal computed tomography (CT) was performed. A pseudoaneurysm originating from the right

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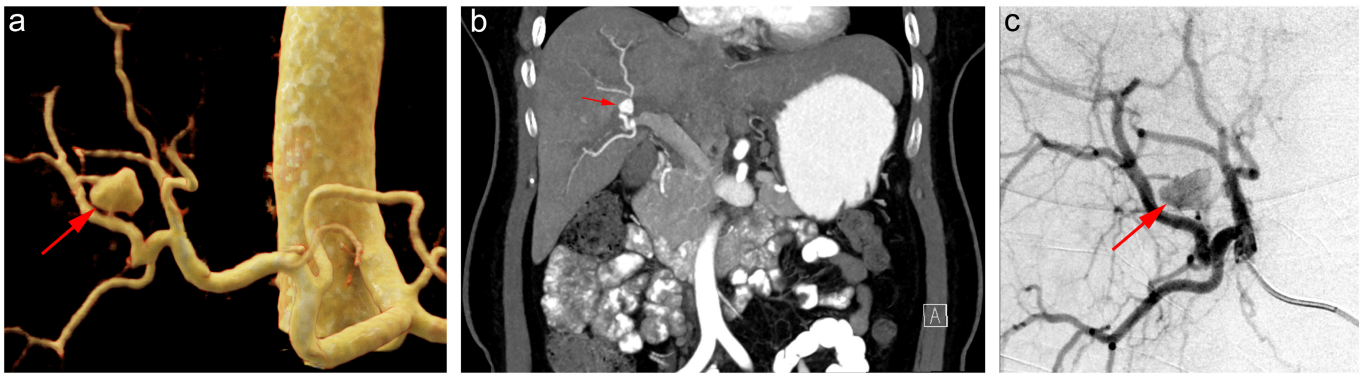

Figure 1. a-c. 3D reconstruction of a contrast-enhanced CT angiography in the arterial phase **(a)** demonstrates an intrahepatic pseudoaneurysm (*arrow*), originating from the superior branch of the right hepatic artery's posterior sectoral branch, supplying liver segment VII with a diameter of 3 mm. Coronal reformation of a contrast-enhanced CT angiography (maximum intensity projection) showing the close proximity of the intrahepatic pseudoaneurysm to the parent hepatic artery branch of liver segment VII and the hepatic veins. **(c)**, Selective digital subtraction angiography (DSA) confirms the intrahepatic pseudoaneurysm (*arrow*).

peripheral hepatic artery of segment VII measuring 12 × 7 mm in diameter adjacent to dilated bile ducts was depicted (Figure 1a, 1b). Increased density of the gallbladder indicated limited hemobilia, while there was no decrease in hemoglobin or clinical bleeding signs.

Endovascular treatment was performed after multidisciplinary discussion and patient's written informed consent. The institutional review board at the participating institution does not require approval for the type of research being performed, where a CE Mark- and FDA-cleared state-of-the-art medical product was used according to clinical indication during an emergency procedure.

Transfemoral access was used to insert a flexible 5 F sheath into the celiac trunk. Selective catheterization of the right hepatic artery was performed by means of a 4 F Cobra catheter. Digital subtraction angiography confirmed the pseudoaneurysm, originating from a small side branch of the peripheral right hepatic artery of segment VII (Figure 1c).

A 2.7 F microcatheter (Progreat®) and, due to significant vessel elongation, another steerable 2.4 F microcatheter (SwiftNINJA®) were used to gain access to the parent vessel. Superselective angiography additionally showed evidence of an arterio-biliary fistula (ABF), which was not identifiable on CT (Figure 2b, Online Supplementary Video 1).

In consideration of the impaired liver function, a combined occlusion of the fistula and pseudoaneurysm without compromising the biliary system and complete preservation of the parent arterial vessel was intended. For this purpose, a microvascular plug (MVP-3Q™; Medtronic, US-MN) was chosen (Figure 2a). A 2.7 F Progreat®-microcatheter was positioned directly into the fistula to the adjacent biliary system. The MVP was advanced via the microcatheter in place. After positioning the MVP along the fistula using the proximal and distal plug markers, the microcatheter was gently pulled back to allow for partial expansion of the MVP. Another contrast injection was helpful in precisely identifying the fistula's origin from the parent hepatic artery branch. Then, the microcatheter and MVP were gently pulled back with the proximal marker just to the fistula's origin (Online Supplementary Video 2). Finally, the MVP was completely deployed by retracting the microcatheter and released from the delivery wire. The final angiogram confirmed the complete exclusion of the pseudoaneurysm and ABF with a patent parent hepatic branch vessel and uncompromised bile duct (Figure 2c, Online Supplementary Video 3).

Abdominal pain was resolved and serum bilirubin levels were decreased to 2.0 mg/dL within 2 days. During a follow-up visit after 4 weeks, the patient revealed no complaints and showed no clinical or laboratory signs of intermittent or recurrent bleeding. Also, there was no indication of possible biliary complications, which are very important in the long term and should be considered during decision-making for the treatment of bleeding ABF in the acute phase.

Main points

- Pseudoaneurysms or arterio-biliary fistulae are rare complications after transjugular liver biopsy or transjugular intrahepatic portosystemic shunt.
- Microcatheter-directed embolotherapy using a microvascular plug allows for immediate and effective superselective occlusion of complex, small vasculature.
- Microvascular plug warrants precise and compact delivery straight to the point without sacrificing the parent vessel.

Discussion

There is a broad spectrum of devices available for endovascular embolotherapy, mostly aiming for the occlusion of the bleeding target vessel.[4] We refrained from performing complete vessel occlusion due to the impaired liver function. The primary aim was to protect the genuine hepatic vasculature and the already diseased dilated bile ducts.

While coils are the most commonly used devices to occlude pseudoaneurysms, retrograde filling by collateral arteries can prevent a sufficient occlusion.[5] We omitted coil-based embolization to prevent uncontrolled obstruction of the parent biliary system due to the associated ABF.

Covered stent grafts allow for anatomic preservation of the parent vasculature.[6] However, rigidity and friction may be challenging for deployment in small and tortuous peripheral visceral arteries.[7] A challenging case published by Defasque et al.[8] showed successful off-label use of a low-profile, highly flexible covered coronary stent to occlude an ABF without occluding the downstream arterial bed. In contrast to our case of an ABF in a peripheral location, the authors treated a central ABF located in the liver hilum.

Alternatively, liquid embolics may be used. However, a highly sophisticated

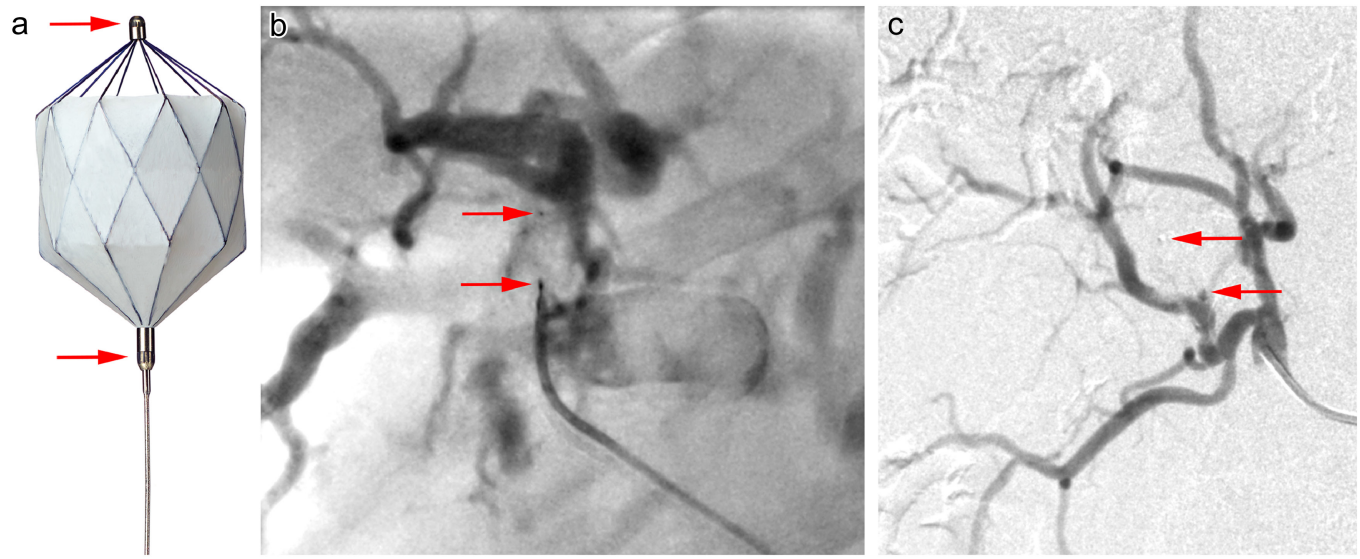

Figure 2. a-c. Photography **(a)** demonstrates the macrostructure of a microvascular plug (MVP-3Q™) consisting of a polytetrafluoroethylene (PTFE)-covered nitinol cage. Image by courtesy of the manufacturer modified by the author. Angiogram **(b)** after positioning and deployment a microvascular plug (MVP) into the arterio-biliary fistula (ABF) second to access using a steerable 2.4 F microcatheter (SwiftNINJA®). *Arrows* indicate the MVP's proximal and distal markers. Final DSA **(c)** shows occlusion of pseudoaneurysm and ABF with uncompromised perfusion of the parent hepatic artery branch after the release of MVP. *Arrows* indicate the MVP's proximal and distal marker.

experience would have been needed to ensure arterial and biliary preservation using glue in our case.

As the usual treatment approaches oftentimes demand the occlusion of parent hepatic artery branches, complications such as central hepatic arterial occlusion and death secondary to acute hepatic insufficiency may occur.[8] Loss of vital liver tissue is especially devastating in patients with impaired liver function due to chronic hepatopathy. Hence, our primary attempt is anatomic preservation of the preexisting vascular system.

The MVP-3Q™ system applied in this case is primarily designed for the occlusion of 1.5-3 mm vessels and represents the first commercially available MVP system delivered through a microcatheter. In this scenario, a standard plug would have been too large to pass into the small peripheral hepatic arteries. After partial or complete deployment by pulling back the microcatheter, the MVP remains fully re-sheathable. This allows repeated repositioning attempts using the proximal and distal markers until a satisfactory treatment position is reached. The MVP's final release is achieved by unscrewing the screw-on mechanism which attaches the device to the delivery cable.

The Woven EndoBridge (WEB™) aneurysm embolization system (Sequent Medical Inc.), typically used for the treatment of wide-neck intracranial aneurysms may be another alternative. However, its high cost contradicted the off-label use outside neurovascular indication. Furthermore, the WEB™ device may not be large enough to properly secure visceral pseudoaneurysms given that the largest WEB device is measuring 11 mm in diameter and 9 mm in height. Also, controlled delivery of such a large WEB™ SL of 11 × 9 device requires a stiffer 0.033" microcatheter, and navigation could be difficult in small and tortuous peripheral visceral vessels.

In conclusion, bleeding control without occlusion of the parent vessel is challenging. In our particular case, the MVP allowed for precise pseudoaneurysm and ABF occlusion originating from a peripheral hepatic artery branch with preservation of the hepatic vascular anatomy.

Video 1: Angiography of a pseudoaneurysm and arterio-biliary fistula, originating from the superior branch of the right hepatic artery's posterior sectoral branch, with dilated bile ducts.

Video 2: Positioning of the microvascular plug (MVP) into the arterio-biliary fistula (ABF). Under fluoroscopic guidance, the microcatheter is gently pulled back to allow for partial expansion of the MVP inside the ABF. The proximal marker is placed precisely at the fistula's origin from the parent hepatic artery branch prior to the release of the MVP from the delivery wire.

Video 3: Final angiography after deployment of the MVP showing a precise occlusion of the pseudoaneurysm and ABF under complete preservation of the hepatic vascular anatomy.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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