Complications of Transjugular Biopsies

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Abstract

Keywords

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Transvenous biopsy was first performed in 1964 by Charles Dotter. Now routinely performed in the liver and kidney by interventional radiologists, the transjugular approach to biopsy has assumed a central role in coagulopathic patients. Major arterial complications from transjugular liver and renal biopsy are rare. In this article, the authors describe such complications in both organs that necessitated selective endovascular coil embolization.

Objectives: On completion of this article, the reader will be able to identify the potential for bleeding complications following transjugular biopsies, as well as the interventional methods used to treat such patients.

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Transvenous biopsy was first performed in 1964 by Charles Dotter.¹ Now routinely performed in the liver and kidney by interventional radiologists, the transjugular approach to biopsy has assumed a central role in coagulopathic patients. Major arterial complications from transjugular liver and renal biopsy are rare. In this article, the authors describe similar complications in each organ that necessitated selective endovascular coil embolization.

Case Presentation No. 1

A 45-year-old man with hepatitis C cirrhosis presented with acute renal failure secondary to cryoglobulinemia. Although coagulation parameters were within normal range (prothrombin time, 15.1; international normalized ratio, 1.2), the patient was thrombocytopenic (37,000 K/ μ L) and refractory to transfusion because of his underlying chronic liver disease. Given, the existing coagulopathy, interventional radiology consultation was sought for a transjugular renal biopsy.

Following initial preprocedural workup, the patient was brought to the angiography suite where the right internal jugular vein was accessed under ultrasound guidance with a micropuncture system (Cook, Bloomington, IN). Under fluoroscopic guidance, a 0.035 inch J wire (Cook, Bloomington, IN) was advanced into the inferior vena cava. The 60.5 cm transjugular sheath and 14-gauge Quick-Core needle biopsy system (Cook, Bloomington, IN) were placed. A 5F 80-cm multipurpose catheter (Cook, Bloomington, IN) was used to select the lower pole right renal vein. Positioning was confirmed by venography using Omnipaque 300 (GE Healthcare, Little Chalfont, United Kingdom) (**► Fig. 1**).

The guide wire was exchanged for a super-stiff Amplatz wire (Boston Scientific, Natick, MA), over which the 14 gauge

Fig. 1 Venogram confirms appropriate access to a lower pole renal vein. However, note that lack of cortical enhancement, which could suggest inadequate peripheral wedging.

inner-stiffening cannula was advanced. The 19-gauge 70 cm (20 mm throw) core biopsy needle was then introduced and directed posterolaterally. A total of four passes were made, each under fluoroscopic guidance. Venography by hand injection of contrast was performed before and after each pass of the core biopsy needle to confirm proper positioning as well as to exclude extravasation from prior passes. Two intervention radiologists were scrubbed in during the retrieval of specimens; one to fire the cutting cannula of the biopsy gun and remove the specimen, and the other to maintain positioning of the stiffening cannula/guiding catheter. The patient tolerated the procedure well and was returned to his intensive care unit (ICU) bed in stable condition. Postprocedure monitoring was overseen by the ICU team.

Within a few hours of the procedure, the patient was noted to develop gross hematuria and a drop in hemoglobin from 10.1 to 8.5 g/dL. The decision was made to bring the patient back emergently to interventional radiology for selective right renal arteriography. The right common femoral artery was accessed using a micropuncture system (Cook, Bloomington, IN). A 5F vascular sheath was then placed. A multi-sidehole infusion catheter was advanced into the abdominal aorta over a guide wire. An aortogram was performed which demonstrated a single right renal artery. Using a 0.035 inch J wire and a 5F RC1 catheter (Cook, Bloomington, IN), the right renal artery was selectively catheterized. A renal arteriogram was performed using Visipaque 320 (GE Healthcare).

Although no vascular injury was identified, a segmental artery supplying the lower pole was further selectively catheterized. Selective arteriogram demonstrated an arteriovenous fistula (AVF) with early opacification of a draining vein (► Fig. 2).

Using a coaxial system, the lobar artery was selectively catheterized with a 2.7F microcatheter (Renegade STC; Bos-

Fig. 2 Selective arteriogram of an inferior pole segmental renal artery demonstrates an arteriovenous fistula with early opacification of a draining vein (arrow).

ton Scientific, Natick, MA). After confirming catheter positioning with superselective angiography, embolization was performed using detachable platinum microcoils (Interlock; Boston Scientific, Natick, MA) (► Fig. 3).

Postembolization, angiogram of the lobar artery and right main renal artery (► Fig. 4) confirmed occlusion of the AVF. The patient's hematuria subsequently resolved with stabilization of his hemoglobin level.

Discussion

Percutaneous renal biopsy, either by ultrasound or computed tomographic (CT) guidance, is the current standard procedure by which glomerular tissue is obtained. This procedure permits direct sampling of the renal cortex without transgressing larger vessels in the hilum and medulla. However, it does require puncture of the renal capsule, placing the patient at risk for significant bleeding complications such

Fig. 3 Microcoil embolization of the lobar artery supplying the arteriovenous fistula.

Fig. 4 Successful embolization of arteriovenous fistula, with non-visualization of the previously demonstrated early draining vein. Note careful sparing of flow to ureteric artery (arrow).

as perinephric hematoma and gross hematuria. Major complications, defined by clinically significant bleeding requiring transfusion or intervention, have been reported to occur in up to 6.4% of the cases.²

Roughly 5% of renal biopsies are contraindicated by this percutaneous approach.³ Common contraindications include bleeding diathesis, maintenance anticoagulation, morbid obesity, ascites, uncontrolled hypertension, and small kidneys.⁴ A transvenous approach has several theoretical advantages in this high-risk population. First, it avoids perforation of the renal capsule, lowering the risk of significant hemorrhage. Second, when bleeding does occur, it should simply return back to the venous system by which it was sampled.⁵ Disadvantages to this access include transgression of the medullary parenchyma and consequent risk of injury to larger central vessels. Also, specific lesions cannot be targeted which partly limits the utility of this technique. Most importantly, the reported major complication rates are highly variable and range between 1 and 40%.^{6,7}

When performing a transjugular renal biopsy, there are a few points to consider with respect to optimizing the technical success rate and preventing complications. First, the right renal vein is preferred because of its shorter length and relatively more direct access route from the inferior vena cava. Second, one should advance the biopsy cannula as distally as possible into a medullary interlobar vein of the lower pole. This ensures cortical sampling and reduces the risk of damage to a large vessel.⁸ Note that this is in contradistinction to the technique for transjugular hepatic biopsy. Third, it is important to angle the biopsy needle laterally and posteriorly to avoid colonic puncture.⁹

The most commonly reported complication with transvenous renal biopsy is capsular perforation. The majority of these are associated with gross hematuria. More severe cases

may result in large retroperitoneal hematomas, which are typically self-limiting from the tamponade effect of the perinephric fat. Misra et al reported no correlation between extravasation seen on venography and bleeding seen at follow-up imaging.² Paradoxically, capsular perforation has been shown to be associated with better specimens in animal studies. It is also interesting to note that no correlation between the number of biopsy needle passes and rate of major complication was seen in a series by See et al.¹⁰ This series did however report a higher risk of capsular perforation.

Concurrent biopsy tract embolization in cases of venographically identified capsular perforation has also been described.³ The biopsy tract may be cannulated with a hydrophilic wire and 5F multipurpose catheter. A Gelfoam (Upjohn, Kalamazoo, MI) pledget may then be placed within the tract. Although this concept may work in theory, it can be difficult to cannulate the tract, and the Gelfoam pledget can become displaced. Also, gelfoam embolization is less likely to be successful in the setting of urinary tract perforation. In addition, clinically significant bleeding occurs from high-pressure arterial bleeding, and embolization of the arterial inflow, rather than the venous outflow would likely be more efficacious at hemostasis. By the same reasoning, it would also be unlikely to diagnose an AVF via postbiopsy venography.

The incidence of AVF after percutaneous renal biopsy is reported to range between 1 and 18%.¹¹ Up to 80% of post-percutaneous biopsy, AVFs resolve spontaneously. Of the reviewed literature, no AVFs resulting directly from transjugular renal biopsy were reported. There was only one documented case of calyceal disruption requiring embolization. Although a transvenous route for biopsy has been touted as a safer choice to the percutaneous option,¹² this case illustrates that major bleeding complications do exist with this approach. Given that larger central vessels are in the path of the transvenous biopsy needle, the potential for major vessel injury should not be ignored. Despite techniques that are intended to limit this risk (i.e., sampling from a distal interlobar medullary vein), the overall technique remains a "blind" procedure with respect to the arterial anatomy. Furthermore, the current existing data are unclear as to the true major complication rate when a transjugular biopsy is performed.

With this in mind, a drop in hemoglobin in the setting of hematuria following transvenous biopsy is an indication for prompt arteriography. Bedside ultrasound can also be considered initially in a hemodynamically stable patient, although high clinical suspicion for bleeding should ultimately be evaluated by angiography. Our clinical scenario demonstrated the potential for a communication between an artery and calyx that most likely extended to the venous outflow given the biopsy technique. Once an AVF is angiographically identified, we prefer transcatheter embolization with microcoils for treatment. Superselective embolization of the affected artery using a coaxial system minimizes loss of renal parenchyma while effectively achieving embolic arrest of the fistula.

Case Presentation No. 2

A 23-year-old female patient with no significant medical history initially presented with new onset nephrotic syndrome and thrombotic thrombocytopenic purpura. Treatment with plasmapheresis was begun over the first 5 days of admission. However, by day 5, the patient developed elevated liver enzymes of unclear etiology. Hepatology was consulted and the patient was referred to interventional radiology for liver biopsy. Despite normalization of the platelet count to 176 K/ μ L and an international normalized ratio of 1.4, transjugular biopsy was requested as a mean towards minimizing the bleeding risk in the setting of recent coagulopathy.

The patient was brought to the interventional radiology suite where the right internal jugular vein was accessed using a micropuncture set (Cook, Bloomington, IN). A 9F vascular sheath was placed and a 5F multipurpose angled catheter (Cook, Bloomington, IN) was used to select the middle hepatic vein for placement of the biopsy system. The right hepatic was not chosen due to an unfavorable angulation relative to the main hepatic vein. Over an Amplatz super-stiff wire (Boston Scientific, Natick MA), a 7F transjugular sheath and 19-gauge 48 cm Quick-Core needle biopsy system (Cook, Bloomington, IN) were introduced into the middle hepatic vein. A total of two core biopsies were obtained. The patient tolerated the procedure well and was released to the inpatient floor in hemodynamically stable condition. Pathologic analysis revealed microvesicular steatosis of the liver.

On postprocedure day 5, the patient began to complain of severe abdominal pain and a complete blood count (CBC) from the morning demonstrated a hemoglobin drop to 6.5 g/dL from a baseline of 10 g/dL. A stat CT of the abdomen and pelvis was subsequently obtained and demonstrated a large parenchymal and subcapsular hematoma (**Fig. 5**).

The patient was brought emergently to the interventional radiology suite for hepatic angiography. Access into the right common femoral artery was obtained using a micropuncture set (Cook, Bloomington, IN) and a 5F vascular sheath was placed. A routine aortogram was forsaken because the arterial anatomy was well delineated by the aforementioned CT. A 5F

RC1 catheter (Cook, Bloomington, IN) was used to select the superior mesenteric artery (SMA). An angiogram of the SMA demonstrated a large accessory right hepatic artery with an abnormal arterioportal fistulous communication (**Fig. 6**).

The arterial branch supplying the arterioportal fistula was selectively catheterized using a microcatheter system (Rene-gade STC; Boston Scientific, Natick, MA) and embolized using 0.018" detachable coils (Interlock; Boston Scientific, Natick, MA) (**Fig. 7**). Detachable coils were chosen to improve precision of deployment and decrease risk of coil migration.

Despite successful angiographic occlusion of the arterioportal shunt, the patient continued to experience a slow drop in hemoglobin over the next 2 days along with persistent hypotension and tachycardia. She was brought back to interventional radiology for repeat angiographic interrogation. Using similar technique for arterial access, an arteriogram of the accessory right hepatic artery was obtained demonstrating multiple punctate areas of capsular microhemorrhage (**Fig. 8**).

Given the diffuse nature of the findings and the patient's hemodynamic instability, Gelfoam (Pfizer, New York, NY) slurry was injected proximally from the accessory right hepatic artery to control the hemorrhage. Postembolization arteriography demonstrated occlusion of the accessory right hepatic artery and its branches along with resolution of bleeding (**Fig. 9**).

The procedure proved clinically successful as the patient's tachycardia resolved and hemoglobin stabilized to baseline over the next few days. The patient complained of mild abdominal pain in the postprocedure period compatible with postembolization syndrome. This was managed effectively with symptomatic pain control only. By the time of discharge 9 days later, the liver function tests had also improved. At 2 months follow-up, the patient's liver function had completely normalized (**Table 1**).

Discussion

A transjugular liver biopsy is validated as an alternative technique to percutaneous biopsy and has been established as an effective procedure for patients at high risk for

Fig. 5 (a) Axial and (b) coronal contrast-enhanced computed tomographic images demonstrate large parenchymal (P) and subcapsular (SC) hemorrhages in the right hepatic lobe. Hounsfield unit density within the subcapsular hematoma was consistent with acute hemorrhage.

Fig. 6 Opacification of the portal vein (arrow) seen during the arterial phase of this superior mesenteric artery injection, compatible with an arteriportal fistula arising from an accessory right hepatic arterial branch.

bleeding.¹³ Also indicated for patients with ascites, hepatic failure, or transplantation, the overall reported complication rate with transjugular liver biopsy is low and ranges between 1.3 and 7.1%.¹³ Most adverse events are limited to minor access site complications such as neck hematomas and pain.^{14–16} Major complications on the other hand are exceedingly rare at 0.5% and occur mostly from capsular perforation and subsequent intraperitoneal hemorrhage. Pneumothorax, direct arterial injury such as pseudoaneurysm or AV fistula, and venous perforation of the inferior vena cava (IVC) or renal

Fig. 8 Accessory right hepatic arteriogram demonstrates numerous peripheral punctate areas of petechial blush indicative of a capsular hemorrhage.

veins comprise the significant remainder of major complications.¹⁷ Of the note, major complications are much higher in pediatric patients and those with smaller livers, likely from increased technical difficulty and risk of perforating the capsule.¹⁸

Parenchymal hematomas as seen in this case are highly unusual (0.05%) and have already been reported previously

Fig. 7 Spot image obtained following superselective coil embolization of the arterial inflow to the arteriportal fistula.

Fig. 9 Post gelfoam angiogram of the accessory right hepatic artery demonstrates nonopacification of the previously seen areas of capsular hemorrhage.

Table 1 Laboratory evaluation following liver embolization for hemorrhagic complication of transjugular biopsy

	Day 0 (periembolization)	Day 9 (discharge)	Day 59 (follow-up)
Total bilirubin	1.7	3.5	0.4
Alkaline Phosphatase	97	168	74
AST	1,257	107	25
ALT	2,853	457	39
Hgb	8.5	9.5	13.3

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; Hgb, hemoglobin.

by our institution.¹⁷ This case is unusual in that parenchymal hemorrhage was observed in addition to capsular perforation and arterioportal shunting, all of which presented in a delayed time frame. Superselective coil embolization was an effective solution for management of the arterioportal fistula. The intraparenchymal bleeding however presumably continued with expansion of the subcapsular hematoma and consequent laceration of the capsular perforating arteries. Although not previously been described in the liver, a similar outcome was observed in a case report of perirenal hemorrhage from transcortical guide wire perforation during renal artery stenting.¹⁹

Hepatic arteries represent end vessels without significant collateral supply and usually need to be occluded proximally to arrest bleeding.¹⁷ Our institutional preference for hepatic embolotherapy is to perform selective transcatheter micro-coil embolization. Ischemic complication is minimized in these cases as dual circulation from the portal venous vasculature maintains perfusion in nontransplanted livers. Biliary necrosis becomes a risk, however, particularly in transplant livers, as the sole blood supply of the biliary tree is derived from the hepatic artery.

In the presented case, the diffuse nature of capsular bleeding on repeat angiography combined with an unfavorable hemodynamic status of the patient prompted nonselective embolization with Gelfoam. In situations such as this, Gelfoam affords the operator the ability to treat hemorrhage rapidly and without the precision needed for accurate deployment of coils.

Various described methods at preventing perforation of the liver capsule include outlining the liver edge with ultrasound, selecting the right hepatic vein, performing hepatic venography, and obtaining a lateral fluoroscopic image before the biopsy to ensure that the cannula is directed anteriorly into the maximal amount of hepatic tissue.¹⁸ We always attempt to perform biopsies in the right hepatic vein when technically feasible and perform hepatic venograms. We do not routinely perform the other listed techniques such as outlining the liver margin, although they should be considered in unique situations such as pediatric biopsies.

To conclude, the overall rate of significant complications with transjugular liver biopsy remains low when considering the selection bias of high risk patients for this technique. Most complications are because of capsular perforation and can be effectively managed endovascularly by transcatheter embolization with coils and/or Gelfoam. A variety of intraprocedural

techniques can be employed to minimize the risk of these potential catastrophic complications.

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