Imaging findings and endovascular management of iatrogenic hepatic arterial injuries

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ABSTRACT
Iatrogenic hepatic arterial injuries (IHAI) include pseudoaneurysm, extravasation, arteriovenous fistula, arteriobiliary fistula, and dissection. IHAI are usually demonstrated following percutaneous transhepatic biliary drainage, percutaneous liver biopsy, liver surgery, chemoembolization, radioembolization, and endoscopic retrograde cholangiopancreatography. The latency period between the intervention and diagnosis varies. The most common symptom is hemorrhage, and the most common lesion is pseudoaneurysm. Computed tomography angiography (CTA) is mostly performed prior to angiography, and IHAI are demonstrated on CTA in most of the patients. Patients with IHAI are mostly treated by coils, but some patients may be treated by liquid embolic materials or stent-grafts. CTA can also be used in the follow-up period. Endovascular treatment is a safe and minimally invasive treatment option with high success rates.

Endovascular management
Transfemoral arteriography is performed under intravenous sedation, and IHAI are clearly identified on angiograms. The location of the lesions may be lobar or segmental hepatic artery, common hepatic artery, gastroduodenal artery, proper hepatic artery, or cystic artery. Coils (mostly pushable coils) are used either alone or with a liquid embolic material. Liquid embolic material alone or stent-grafts may also be used in some patients. Follow-up is performed by CTA.

Pseudoaneurysm
After a disruption in the arterial wall continuity, blood dissects into tissues under the high arterial pressure and a sac that has a communication with the arterial lumen forms. This sac,
called PA, is surrounded by the media, adventitia, or soft tissue (7). Blood extravasation into the sac leads to the formation of a fibrous capsule. This capsule displays progressive enlargement that causes PA to have a higher rupture risk than a true aneurysm (8). Previous studies (2, 8) reported that PA seems to be the most common IHAI, and rupture in iatrogenic PAs of the hepatic artery is also common with a rate of 21%–80%. Asymptomatic patients with PA should also be treated because of the high rupture risk (8). PA is seen either isolated (Fig. 1) or with another IHAI. PAs are usually detected following percutaneous transhepatic biliary drainage (Fig. 2), pancreaticoduodenectomy, percutaneous liver biopsy, laparoscopic cholecystectomy, endoscopic retrograde cholangiopancreatography, and mass excision. Coils are the first preferred embolic material in most patients, while liquid embolic materials such as glue, thrombin, or polyvinyl alcohol can be used in some patients (1). Covered stent-graft can be used in patients who have a PA with a narrow neck (Fig. 3).

### Extravasation

Extravasation that can be detected by CTA or angiography is defined as migration of blood out of the vessel into the gastrointestinal lumen or the peritoneal cavity (Fig. 4). Extravasation is seen either isolated or with a PA. The etiology and treatment of extravasation are similar to those of PA (1).

### Arteriovenous fistula

Hepatic AVFs are abnormal communications between the hepatic artery and the
portal or hepatic vein without an intervening capillary bed (9). The hepatic arteriole and portal venule show close proximity and they are located in the portal triad along with the biliary tract. This may cause the incidence of APF or ABF following biopsy to be more than the incidence of a fistula between the hepatic artery and the hepatic vein (9, 10). APF is mostly seen following percutaneous liver biopsy (Fig. 5) and to a lesser extent following other percutaneous interventions (9).
Arteriobiliary fistula

An ABF is an abnormal communication between the hepatic artery and the biliary system. ABF presents rarely, following percutaneous transhepatic biliary drainage or other percutaneous interventions (10). It may be associated with an extrahepatic biliary injury.

Dissection

An arterial dissection is separation of the layers of the arterial wall, and it may be associated with aneurysm formation later. Dissection occurs during the intervention (Fig. 6) and is treated by balloon-expandable stent-graft.

Conclusion

IHAIs are diagnosed by CTA or catheter angiography (2). Kumar et al. (11) reported the usefulness of CTA prior to angiography in management of patients with massive hemobilia. Previous studies (1, 12) reported a rate of 80%–100% for successful embolization of IHAIs. Superselective embolization performed as distal as possible minimizes complication rates and loss of hepatic artery flow. The choice of embolic material should be based on cost, technical ease of use and effectiveness of permanent occlusion with minimal loss of hepatic arterial flow. Although some uncommon complications such as migration of the embolic material (8), bile leakage (12), coil erosion into the common bile duct (13), hepatic abscess and gallbladder fibrosis (14) were reported after hepatic arterial embolization, the mortality and morbidity rates of endovascular embolization are lower than those of surgery (5).

In conclusion, IHAIs should be considered in patients with hemorrhage following an invasive upper abdominal procedure. In cases of IHAI, endovascular treatment can be performed safely and effectively with high success rates.

Conflict of interest disclosure

The authors declared no conflicts of interest.

References