Transcatheter Treatment of Liver Laceration from Blunt Trauma

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Abstract

Keywords

- blunt hepatic trauma
- liver active extravasation
- hepatic artery embolization
- interventional radiology

Blunt hepatic trauma is a fairly common pathology seen in trauma centers. We describe a pediatric patient who suffered blunt hepatic trauma that was managed successfully with a combination of exploratory laparotomy and liver packing, followed by hepatic artery embolization by interventional radiology (IR) after he continued to have significant arterial extravasation. Also discussed are trends in overall blunt hepatic trauma management and the technique of IR management.

Objectives: Upon completion of this article, the reader will be able to describe interventional radiology management of active bleeding of the liver from trauma, especially in conjunction with initial surgical management.

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Case Presentation

A 6-year-old boy presented by air ambulance after a fall from a second-story window onto concrete. He was not hypotensive in the field but became so (systolic blood pressure of 50 to 60 mm Hg) upon arrival to the hospital. His Glasgow Coma Scale score was 10. An endotracheal tube was placed and fluid resuscitation was started. He responded to fluid resuscitation with an increase in systolic blood pressure to ~100 mm Hg but was persistently tachycardic with his heart rate ~160 beats per minute. His mucosal surfaces were pale

and extremities were cool to touch, consistent with hemorrhagic shock. There was no hemothorax, pneumothorax, or pelvic fracture on radiographs of the chest and pelvis. Focused assessment by sonography for trauma (FAST) demonstrated free fluid in the abdomen, suggesting an intra-abdominal source of hemorrhage. He was taken emergently to the operating room for exploratory laparotomy, where he was found to have a massive hemoperitoneum and a grade 4 liver laceration in segment 7 extending into the hilum with active hemorrhage. Arterial hemorrhage was suspected; initial hemostasis was achieved with perihepatic packing. The rest of the abdomen was explored and then temporarily closed. Due to the suspicion of arterial hemorrhage and ongoing blood transfusion requirement, a postoperative computed tomography (CT) scan with intravenous contrast was performed, showing a large area of contrast extravasation originating from the right hepatic arterial branch extending into the right lobe of the liver with a large hematoma (►Fig. 1).

Diagnosis

Hepatic laceration with arterial hemorrhage sustained due to blunt abdominal trauma (in this case, continuing after initial surgical management).

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Figure 1 Postoperative computed tomography scan demonstrating a large area of active extravasation originating in the right hepatic artery (open black arrow) extending into the right lobe of the liver and large hematoma. Packing material around the liver is also noted (arrowhead).

Treatment

The patient was taken to the interventional radiology (IR) suite, and selective hepatic arteriograms were performed that confirmed active extravasation from a right hepatic arterial branch (► **Fig. 2A**). Unsuccessful attempts were made to place a microcatheter distal to the injured artery. A “coil sandwich” technique was attempted, whereby coils are placed distal and proximal to the site of injury. This proved unsuccessful because the microcatheter could not be placed in a distal enough location. The microcatheter was advanced as far distally as possible while avoiding further injury or arterial spasm, and the vessel was initially embolized with three Tornado 3 × 2 mm coils (Cook Medical Inc., Bloomington, IN). An arteriogram performed immediately after coiling demonstrated persistent extravasation (► **Fig. 2B**). Further embolization with Gelfoam slurry resulted in cessation of arterial bleeding

on a subsequent arteriogram (► **Fig. 2C**). After embolization, the patient remained hemodynamically stable and did not require further transfusion. The patient was returned to the operating room 2 days later for the removal of packing and closure of the abdomen. He did well and was discharged on hospital day 28. He was last seen in clinic 2 months after injury and was doing well without complications.

Discussion

Over the past few decades, management of blunt liver trauma has shifted from operative toward nonoperative management. This shift away from operative intervention occurred with a resultant decline in mortality.¹ One treatment modality, hepatic arterial embolization (HAE), can be used in multiple scenarios involving blunt hepatic trauma. In the case presented here, HAE was as an adjunct to operative management after the patient continued to hemorrhage following initial surgery. Recent data also support the more controversial primary use of HAE in the acute setting of blunt liver trauma for patients who show borderline hemodynamic stability during and after fluid resuscitation or who are hemodynamically stable enough to tolerate CT evaluation.² HAE can also be useful when used nonacutely in the trauma setting for delayed hepatic hemorrhage, or even for prevention of hemorrhage for trauma-induced processes that have an increased risk of hemorrhage, such as pseudoaneurysms and arteriovenous fistulas.³

From the standpoint of the Trauma Surgical Society that usually manages blunt abdominal trauma, most of the patients with blunt hepatic trauma can be managed successfully without an operation. However, ~14% of patients still require surgical intervention.⁴ Operative intervention is generally reserved for patients with hemodynamic instability; these patients often have complex injuries. The initial assessment and resuscitation of patients with blunt abdominal trauma follows an organized approach as outlined in the Advanced Trauma Life Support program. A search for intra-abdominal sources of hemorrhage can be performed by FAST or diagnostic peritoneal lavage in unstable patients, or by abdominal-pelvic CT in more stable patients. The indications for

Figure 2 (A) Selective hepatic arteriogram confirmed active hemorrhage from the right hepatic arterial branch and arteriportal fistula. Arrow indicates portal vein. (B) Hepatic arteriogram following right hepatic artery coil embolization, demonstrating persistent contrast extravasation and/or visualization of the portal vein (arrow). (C) Successful hemostasis of right hepatic arterial hemorrhage after further embolization with Gelfoam slurry.

abdominal exploration in the setting of blunt hepatic trauma are peritonitis and hemorrhagic shock.

In a patient with blunt hepatic trauma who is hemodynamically unstable, operative intervention is indicated. The initial surgical maneuvers usually involve manual compression and packing of hepatic injuries. In most instances, perihepatic packing is adequate for controlling hemorrhage.^{5,6} It is important that definitive management of the liver injury is not performed at the initial operation; rather, packing should be left in place, and the patient's abdomen temporarily closed. Reexploration for packing removal and definitive repair is addressed at a later date after stabilization of the patient and correction of metabolic derangements.

Active arterial bleeding after perihepatic packing has been found to be as high as 60% in some series.^{7,8} However, HAE can be associated with complications including major hepatic necrosis (including bile leak, abscess, need for further surgery for hepatic debridement, and death) and nontarget embolization, especially gallbladder necrosis.^{9,10} Currently, there are not sufficient data to support a recommendation for routine postoperative angiography; it should be considered in a case-by-case basis. In the patient presented here, significant arterial bleeding was suspected intraoperatively and confirmed with CT scan with intravenous contrast, warranting further evaluation and treatment with HAE.

HAE technique involves standard arterial interventional techniques. In addition to standard 5F catheters, microcatheters (~3F) may need to be used so that the embolization is as selective as possible (within the time constraints of a delay with a potentially unstable patient). Being as selective as possible is important for two reasons. First, although the liver parenchyma has two separate blood supplies (hepatic artery and portal vein), parenchymal necrosis is a possible complication of HAE. For this reason, an angiogram of a splanchnic artery (preferably the splenic or superior mesenteric artery) should be carried through the portal venous phase to ensure normal hepatopetal flow. If this is not present, HAE carries a much higher risk of significant necrosis. Second, the liver has a rich collateral supply. If, as is often the case, the radiologist is unable to use the preferred "sandwich technique" of embolic material on both sides of the artery supplying the extravasation, there is the possibility that collaterals will continue to supply the lacerated and extravasating artery via retrograde flow. The more distal/ selective the embolization, the less likely this is to occur.¹¹ Coils and/or gelatin-based material (e.g., Gelfoam slurry [Pfizer, New York, NY]) are used at our institution for the embolic material. Particles are also frequently used.¹²

In the case of more widespread multifocal extravasation, treatment may need to be more quickly performed with embolic material into one of the more proximal arteries (e.g., Gelfoam "slurry in a hurry"), which then treats a large volume of bleeding liver parenchyma. If this course is chosen, care should be taken to identify and place the catheter tip distal to the cystic artery to prevent gallbladder infarction, and embolization should be observed under continuous fluoroscopy to prevent reflux of embolic material proximal to the catheter tip. The most common complications of HAE are nontarget embolization and catheter-related vascular

injury. As stated, it is important that the cystic artery be identified and all attempts made to place the embolic material distal to its origin; this is particularly important if smaller embolic materials (e.g., small particles, Gelfoam) are used.¹¹

After HAE, imaging follow-up is recommended, although there is no general agreement on what this should be.¹³ One approach is to perform follow-up CT to demonstrate resolution of imaging abnormalities and to evaluate for the development of delayed complications. Other imaging algorithms that have been suggested are used to evaluate for bile leak/biloma. It has also been noted that blunt liver trauma can be complicated by delayed hemorrhage due to pseudoaneurysm rupture, and there has been a connection shown between biloma/ bile leak and pseudoaneurysm formation. If evidence of bile leak is present, imaging to detect a pseudoaneurysm should be undertaken.³ Posttraumatic pseudoaneurysm, as well as arteriovenous and arteriportal fistulas, can cause delayed hemorrhage in the setting of blunt hepatic trauma; these vascular injuries respond well to HAE.

Teaching Points

- Management of blunt hepatic injury with arterial hemorrhage is often a joint effort between surgery and IR. Stability of the patient in response to fluid resuscitation is a key factor in determining whether operative management or endovascular techniques are likely to have the most beneficial outcomes.
- HAE to control arterial hemorrhage may be used alone or after surgical stabilization/ packing.
- Standard interventional techniques are used to gain access to the hepatic arterial system; microcatheters allow more selective tip placement.
- A portal venogram should be performed. Absence of hepatopetal portal venous flow is a relative contraindication to performing HAE because it greatly increases the risk of clinically significant hepatic necrosis. These risks must be weighed against the potential benefits of the embolization procedure.
- The cystic artery should be identified on arteriography and all attempts made to avoid embolizing it. The gallbladder is a frequent site of nontarget embolization, and gallbladder necrosis can be clinically significant.
- If possible, once the bleeding artery is identified, "sandwich technique" embolization of the artery (embolic material both distal to and proximal to the takeoff of the compromised artery) should be performed. This will prevent the rich collateral arterial supply from continuing to supply the bleeding artery. However, this is often not possible; in this case, embolizing as selectively as possible decreases the risk of continued bleeding.

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