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Interventional radiology in the management of hepatic injuries

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The liver is the most commonly injured abdominal organ in blunt trauma and a common injury after penetration. Iatrogenic hepatic damage can also result from biopsies and other invasive procedures. Currently mortality associated with liver injury is high ranging from 13%~ 17%. Exsanguination is the common cause of death. There are three types of hepatic injuries. One third are rather minor and superficial. They result in minor hemorrhage and require little treatment. The second third are more serious and result in deeper lacerations and parenchymal hematomas of considerable size. The remainder are very serious injuries which result in transection of major hepatic arterial and portal branches or in avulsion of the liver or the hepatic veins.

The standard surgical treatment of these injuries is laparotomy. Simple sutures and drainage exploration of the depths of bleeding injuries and ligation of specific bleeding vessels and abdominal packing are among the common maneuvers performed during surgical exploration.

The recent introduction and acceptance of computed tomography as a valid safe and expeditious method of identifying hepatic injuries has enable us to take a more conservative approach. Nonoperative management of hepatic injuries has gained considerable favor in the United States as an alternative to exploratory laparotomy. There are several advantages of this method. Surgical exploration of liver injuries is often associated with increase in hemorrhage because the mobilization of the liver results in bleeding from small vessels which will not bleed if undisturbed. Secondly, avoiding laparotomy decreases the risks of infection. Thirdly, exploration results in loss of body heat and this Hypothermia causes coagulopathy which may worse hepatic hemorrhage.

Many patients with liver injuries, especially those resulting from car crashes and falls, are hemodynamically stable after there injury. They do not bleed significantly, do not go into shock and do not require blood transfusions. Many of these injuries are relatively small, superficial lacerations which do not compromise any of the major hepatic vasculature. Frequently these minor injuries appear on CT as small hematomas or linear lacerations which parallel the portal triad. The fracture appears to extend along the lines of the portal triad and no major vessels are transected. If CT does not show any additional injuries to other organs such as the small intestine or the pancreas, it is often best to observe the patient and follow their blood count to look for anemia. Only when blood loss is significant and when transfusions are required is the interventional radiologist required for these types of injuries. Best rest alone will give a good outcome in the initial phase of treatment. One must worry about complications of infection or leakage of bile, but these problems occur in a delayed fashion.

Other hepatic injuries are more complicated and more often need some method of hemostasis. CT often shows very large hematomas, the fractures cross over the portal triad resulting in transection of these vessels, or active extravasation may be seen. Hemor

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collections of bile in the liver and fistulas between the bile ducts and the kidney, the pleura or the skin. They can be diagnosed by biliary scintigraphy or endoscopic cholangiography. The treatment of bile collections is by percutaneous drainage of the collection using CT or ultrasound for guidance. After drainage, biliary fistulas usually close spontaneously. However, when there is massive biliary leakage, biliary drainage via ERCP or by poercutaneous drainage of the biliary tree under fluoroscopy should be attempted. This can be very difficult because the biliary tree will not be very dilated. Remember that because there is leakage, bile duct may not be obstructed and the bile duct will be small. Rarely stenting of transected biliary ducts can be helpful. Occasionally persistent drainage from small transected ducts can be controlled by sclerosing the bile duct with ethanol. This should only be done when there is no flow into the main biliary ducts. We do not want to sclerose the main bile ducts.

Another complication which is not uncommon is a post-traumatic infection. Intraparenchymal hepatic hematomas or bile collections may become infected Areas of the liver may become devascularized by the trauma and this can also lead to hepatic abscess formation. Hematomas in the peritoneal cavity can also be contaminated by bile and become peritoneal abscesses. Drainage of post-traumatic abscesses is usually easily accomplished percutaneously using CT or ultrasound for guidance. The catheter should be kept in until the abscess has cleared and the infected space has become scarred. Periodic contrast injections through the drainage catheter is rcommended before removal of the drain so that we can diagnose biliary fistulas. These biliary infections may take a longer time to heal. In summary, hepatic trauma is common and potentially life-threatening. However, most patients with liver injury can be managed by nonoperative treatment. If bleeding persists, one should consider angiography as a method of diagnosing hepatic bleeding from arterial sources. Once diagnosed, advancing the catheter near the site of hemorrhage to embolize the bleeding site should be considered. It is a highly effective method of treating many of the these patients. Complications of hepatic trauma such as biliary leakage, delayed gastrointestinal hemorrhage and intraabdominal and intrahepatic abscesses can usually be managed by the radiologist.

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Transcatheter arterial embolization for difficult post-traumatic arterlovenous fistulas

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Post traumatic arteriovenous fistulae are abnormal potentially life-threatening communications between adjacent arterial and venous structures. They comprise approximately 10% of all vascular injuries and are usually caused by penetrating trauma. The majority occur in the peripheral vascular tree but may be occur in the neck and scalp, in the abdomen between systemic arteries and veins or between systemic arteries and portal tributaries or in the chest between the pulmonary arteries and veins. They may result in congestive heart failure, varicose veins and stasis ul-

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rhage in these situations is common and profuse. These fractures tend to occupy multiple hepatic segments. Some of these patients may also do well with bed rest but when bleeding requiring transfusion occurs, angiography should be done without delay.

Another class of hepatic injuries are those which involve the major hepatic veins or the retrohepatic inferior vena cava. These injuries may result in avulsion of the right hepatic vein or its tributaries or laceration of the inferior vena cava. These patients are often hemodynamically unstable because of profuse bleeding. In such situations, exploratory laparotomy is the recommended approach. However, if the patient can be stabilized, it is helpful to make the diagnosis of these injuries preoperatively so that an intelligent decision regarding exploratory laparotomy can be made. It is vital that operation be avoided whenever possible. The exploration of the liver by the surgeon may make worse the bleeding from the hepatic veins because he must mobilize the liver form its bed to inspect it and this may cause more bleeding. Treatment of hepatic vein injuries by stenting the injured segment has been reported but this is anecdotal.

Angiography should include aortography, and selective studies of the celiac artery, the superior mesenteric artery. The purpose of aortography is to detect other sources of bleeding and the define the hepatic arterial anatomy. Selective hepatic arteriography is necessary to identify the site of arterial bleeding. Multiple angiographic views are usually required to see the origin of the injured vessels. Superior mesenteric arteriography is necessary to look for accessory or replaced hepatic arteries and to prove that there is portal blood flow to the liver.

The liver has a dual blood supply from the hepatic arteries and the portal veins. Portal blood flow accounts for 80% of the blood supply to the liver and the oxygenation of portal blood flow is sufficient to provide perfusion and oxygen to the liver cells. If the portal vein is thrombosed and the hepatic arterial branches are occluded by embolization, there may be insufficient blood flow to the liver and hepatic necrosis may occur. Furthermore if there is cirrhosis and there is diminished portal flow to the liver, embolization of the arteries may be much riskier and we would be more cautious in these circumstances.

If arterial bleeding is seen and there is good portal blood flow, then embolization is a safe and effective treatment for arterial hemorrhage. The embolization agent of choice in this circumstance is gelfoam pledgets soaked in contrast media. Gelfoam causes a mechanical obstruction of the blood vessel. It may be digested by macrophages and therefore gelfoam embolization may be reversible after six weeks. This is desirable in trauma victims because the liver is usually normal except the traumatic lacerations. There is no reason to do embolization with a more permanent agent. Coils are less desirable because it is time-consuming and more difficult to place the coils deep at the site of hemorrhage. However, when there are fistulas between the hepatic artery or the hepatic vein or between the hepatic artery and portal vein, then large vessel occlusives such as coils should be used as close to the fistula as possible.

It is desirable to place the angiographic catheter as close to the site of bleeding as possible. This will avoid sacrifice of hepatic arteries which are not injured. Moreover, embolization of the cystic artery to the gallbladder will be avoided. Embolization of the cystic artery has been shown to be associated with infarction or chronic ischemia of the galbladder because this organ does not have blood flow from the portal vein circulation.

There are other complications of liver injuries which can also treated by interventional radiology. These include other hemorrhagic complications, such as hematobilia and portal hypertension. Hemobilia is caused by a connection between an hepatic artery branch and a bile duct. The patients present with gastrointestinal hemorrhage, obstructive jaundice and biliary colic resulting from blood clots within the biliary tree. Traumatic poortal hypertension results from connections between hepatic artery branches and portal vein branches. This raises the portal pressure and can cause variceal bleeding.

Other complications can also occur. Bile duct injuries can result from bile duct lacerations at the time of the trauma. They may present as biliary ascites.