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BRIEF COMMUNICATIONS

SPLENIC ARTERY ANEURYSMS OCCURRING IN LIVER TRANSPLANT RECIPIENTS[1]

Splenic artery aneurysms (SAA)* are found in 0.1% of the cases in large autopsy series (*1*) and in 0.8% of unselected abdominal aortograms (*2*). The incidence of SAA is higher in patients with portal hypertension, in whom it is reported to occur in 8.8% to 50% of cases (*3*, *4*). Rupture of SAA carries a high mortality rate.

Rupture of SAA in liver transplant recipients has been reported (*4*, *5*). To assess the importance of this complication in the liver transplant population, we reviewed the medical records of all liver recipients whose 1311 transplants were performed at the Presbyterian University Hospital from January 1, 1988 until July 1, 1990. Of 5 patients with ruptured SAA, 4 died. An additional patient was recognized to have a SAA following his second orthotopic liver transplantation and this was removed electively by splenectomy and distal pancreatectomy. Summaries of these 6 cases are in Table 1.

SAAs are the most common visceral arterial aneurysms and account for 60% of all aneurysms found within the splanchnic arterial bed (*2*). The pathogenesis of SAA is multifactorial, and Stanley et al. (*2*) have recognized 4 conditions that place patients at high risk: (1) arterial dysplasia, (2) portal hypertension, (3) focal arterial inflammatory processes, and (4) multiparity in women. Anatomically, about 70% of the SAAs in patients with cirrhosis and portal hypertension are located in the distal third of the artery, and half of the aneurysms are multiple (*2*, *3*). In our series, 4 of the 5 liver transplant patients had aneurysms greater than 2 cm in diameter, and one had multiple aneurysms.

Multiple factors could contribute to the higher incidence and larger size of SAAs in patients with chronic liver disease and portal hypertension. These include: increased splenic and overall splanchnic blood flow secondary to arteriovenous shunts and collateral formation; dilatation and elongation of the splenic artery (*6*, *7*); increased cardiac output and splanchnic vasodilatation from hyperglucagonemia (*8*); and vascular changes caused by other hormone changes, such as those which "feminize" male cirrhotic patients (*9*).

Whatever the explanation, the impact of SAA in liver transplantation needs emphasis. In a recent study at the Mayo Clinic (*4*), 60 patients with portal hypertension who were being considered for OLT were submitted to routine preoperative celiac angiography, and 5 (8.3%) were found to have SAA 8 to 25 mm in diameter. A sixth patient in this series developed a SAA 3 months postoperatively. The size at which an asymptomatic SAA should arouse alarm has been reported to be 15 mm (*4*, *5*). There have been no reported ruptures of smaller SAAs in liver transplant recipients. Whatever the size, most SAAs are asymptomatic, as in 4 of our 5 patients. Pain in the mid upper or left upper quadrant of the abdomen is an ominous portent of imminent or contained rupture (*2*, *10*, *11*).

The question of critical size of SAA in liver transplant candidates or recipients should be left open until there is more information. The incidence of rupture of documented SAA in nontransplant patients is 3% to 10% (*2*), but extra risk factors in liver recipients could include the higher rupture rate following any intraabdominal operation (*12*), abrupt changes in celiac trunk blood flow caused by OLT (*6*, *7*), the addition of postoperative corticosteroids, inadvertent trauma to the aneurysm intraoperatively, opening of the retroperitoneal space, and the coagulopathy that often is a feature of perioperative recovery.

Only one previously reported patient has survived a posttransplant SAA rupture (*4*), and in our series, the mortality rate following rupture was 80%. Improvement will require identification of the pathology during pretransplantation workup. MRI is the most discriminating procedure, and we recommend it routinely. Doppler ultrasound of the splenic artery is less discriminating, and angiography is too dangerous in many patients with end-stage liver disease. With MRI, other essential information about liver size, portal vein patency, and the structure and flow patterns of the visceral arterial supply are obtained at the same time (*13*).

Operative management should include ligation of the splenic artery distal and proximal to the aneurysm and resection if feasible (*5*). Proximal splenic artery ligation alone is apt to be ineffective because of rich collateral arterial supply. A delayed operation may be indicated if multiple or large distal SAAs are found that can not be ligated without splenectomy at the time of orthotopic liver transplantation. Although there may be a role for splenic artery embolization before or after transplantation, we have not had personal experience. Splenic infarction and the formation of a splenic abscess is a potential complication of either splenic artery ligation without splenectomy or of embolization.

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* Abbreviation: SAA, splenic artery aneurysm.

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TABLE 1. Summary

OLTx No.	Age (yrs)	Sex	Diagnosis[a]	Time of rupture post OLTx	Outcome	LFT's at time of presentation		Pathology	Comments
1921	32	F	HVC hepatitis	45 days	Died	SGOT SGPT PHOS GGT Bili	104 IU/L 62 IU/L 156 IU/L 103 IU/L 11.2 mg%	3-cm solitary SAA with necrotic wall	(1) Elective splenectomy 8 years pre-OLT (2) Splenic artery ligated as treatment for rupture (3) Second OLT postoperative day 50 (4) Died postoperative day 124
1725	43	F	Autoimmune hepatitis	49 days	Died	SGOT SGPT PHOS Bili	157 IU/L 151 IU/L 210 IU/L 1.3 mg%	3-cm solitary SAA, splenic artery tortuous and thin-walled	(1) Sudden death in hospital (2) Autopsy showed rejection of liver
1897	37	M	Sclerosing cholangitis	56 days	Died	SGOT SGPT PHOS GGT Bili	18 IU/L 23 IU/L 80 IU/L 76 IU/L 10 mg%	No size of aneurysm reported	(1) First OLT primary graft dysfunction (2) Retransplanted on postoperative day 3 (3) Explored for bleeding on postoperative day 4 (4) Died suddenly at home on postoperative day 56
1552	37	F	HBV hepatitis	10 days	Died	SGOT SGPT GGT PHOS Bili	23 IU/L 33 IU/L 37 IU/L 46 IU/L 0.9 mg%	2-cm SAA with arterial sclerosis and perforation	(1) Collapsed in the hospital (2) Died of irreversible shock 24 hr after splenectomy
1352	22	M	HVC hepatitis	—	Alive	SGOT SGPT PHOS GGT Bili	31 IU/L 4 IU/L 147 IU/L 57 IU/L 2.1 mg%	Tortuous artery with multiple aneurysms, largest 2 cm	(1) First OLT lost 14 months postoperative to recurrent HVC hepatitis (2) Following second OLT complained of persistent left upper quadrant pain (3) Angiography revealed lesion (4) Treated with splenectomy and distal pancreatectomy
1568	36	F	Sclerosing cholangitis	6 days	Alive	SGOT SGPT PHOS GGT Bili	67 IU/L 416 IU/L 187 IU/L 190 IU/L 5.9 mg%	No size of aneurysm reported	(1) Collapsed in the hospital (2) Underwent emergency splenectomy (3) Alive and well

[a] All had chronic liver disease and cirrhosis. HVC, C hepatitis; HBV, B hepatitis; PNC, postnecrotic cirrhosis; OLT, orthotopic liver transplantation.

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ISOLATED SPLENIC VEIN THROMBOSIS AS A CAUSE OF MASSIVE UPPER-GASTROINTESTINAL BLEEDING FOLLOWING ORTHOTOPIC LIVER TRANSPLANTATION

Vascular and biliary complications (*1–4*) are among the major postoperative complications associated with orthotopic liver transplantation. These are more common in the pediatric age group, particularly because of technical difficulties associated with anastomosing smaller conduits (*5*). Although not always fatal, vascular complications, such as thrombosis or stenosis of the hepatic artery or portal vein, can cause severe morbidity (*1, 4, 6*), or necessitate retransplantation (*7, 8*). A leak from the biliary anastomosis, while sometimes secondary to an hepatic artery complication (*4*), can also complicate the postoperative course, leading to infections and/or other local problems (*1*).

Massive variceal bleeding following OLT has been reported to occur secondary to portal vein thrombosis (*6, 9–11*). Other reported causes of severe UGI bleeding include cytomegalovirus gastroenteritis, peptic ulcer disease, and bleeding from the choledochojejunostomy anastomosis (*1*). We report massive variceal bleeding following OLT that occurred secondary to isolated splenic vein thrombosis and resultant left-sided portal hypertension. This was preceded by a biliary anastomotic leak that was managed with percutaneous drainage. The patient required operative gastrotomy for oversewing of bleeding gastric varices and splenectomy.

A 14-year-old girl was admitted to the pediatric intensive care unit with fulminant hepatic failure secondary to newly diagnosed Wilson's disease. She developed acute renal failure secondary to hemolysis, and postdilutional hemofiltration was initiated. On the fifth hospital day she was encephalopathic (stage IV), required mechanical ventilation for respiratory failure, and epinephrine and norepinephrine for blood pressure support, when a donor liver became available. The donor (age 58) liver had no gross vascular anomalies, and the OLT was performed in the standard fashion: i.e., end-to-end suprahepatic and infrahepatic inferior vena cava (IVC)* and portal vein (PV) anastomoses, and anastomosis of the donor celiac trunk to the recipient hepatic artery at the trumpeted common hepatic artery (CHA) bifurcation. The biliary conduit was reconstructed using an end-to-end choledochocholedochostomy with a T-tube stent. Venovenous bypass was not used (*12*).

During the operation, she underwent continuous hemofiltration via femoral arterial and venous lines. At the end of the operation, external cardiac compression was necessary. Positive and expiratory pressure (PEEP) of greater than 45 was required for sufficient ventilation.

During the first week postoperatively, her renal function improved although liver function remained poor. She demonstrated massive fluid requirements, and her weight increased from 60 kg to greater than 100 kg. Her abdominal girth nearly doubled, without evidence of bleeding. This caused increased tension on the T-tube and was the probable cause of the biliary anastomotic disruption that was identified by T-tube cholangiogram. By Doppler/ultrasound (US), the PV, CHA, and IVC were all patent. Bile extravasation was mostly medial and in the lesser sac area. This was managed nonoperatively with a percutaneous transhepatic biliary stent. A separate drain was placed in the collection. *Candida albicans* and *enterococcus* were recovered from this collection and simultaneously obtained blood cultures. The patient was placed on appropriate antibiotic therapy, and the left side of the incision was opened due to *Candida* wound sepsis. This wound later dehisced. There was no evidence of pancreatitis by changes in serum amylase or abdominal CT scan. The patient continued to have persistent fevers and cholangitis for 2 weeks and required reaspiration of a second lesser sac collection. Repeat cholangiograms showed improvement, and gradually she began to recover. Her liver function showed slow but steady improvement. One month after the first biliary drainage procedure, she experienced UGI hemorrhage requiring transfusion of 3 units of packed RBCs. UGI endoscopy revealed a bleeding ulcer on the lesser curve of the stomach, which was cauterized. There was no evidence of esophageal or gastric varices, erosive gastritis, or peptic ulcer disease. At the same time a Doppler/US examination again showed patent vessels and hepatopetal portal flow. Her liver function remained stable, and there was no change in her coagulation profile, which was normal. One week later she had an episode of massive UGI bleeding that was not controllable with endoscopy. Doppler/US examination again did not reveal any abnormality in the vessels in the portahepatis. Celiac, splenic and superior mesenteric arteriograms did not show an arterial source. However, in the venous phase, thrombosis of the splenic vein in the segment proximal to the portal vein confluence (central splenic vein thrombosis), and numerous gastric varices were demonstrated. The main portal vein was patent. The patient then underwent gastrotomy with suture ligation of bleeding gastric varices and splenectomy. Postoperatively, she developed a pseudocyst in the pancreatic tail that resolved following percutaneous drainage. Subsequently, the patient recovered with steadily improving liver function and was discharged home approximately 4 months following transplantation. She continues to do well more than one year after the transplant and is back in school.

UGI bleeding occurring after OLT has been reported following portal vein thrombosis, CMV gastroenteritis, stress or steroid-related gastritis, peptic ulcer disease, and in association with the choledochojejunostomy anastomosis (*1, 6*). PV stenosis or thrombosis usually results in deterioration of liver function, as well as portal hypertension that can lead to variceal bleeding (*6*). PV thrombosis or stenosis after OLT often requires revascularization (*9–11*) or retransplantation (*7, 8*). In the case presented, PV flow and liver function remained unaffected during the bleeding episodes. The source of bleeding was initially thought to be arterial because of endoscopic findings and the persistence of the Doppler-demonstrated patent portal vein. Arteriography was performed in order to embolize a potential arterial source, but instead it demonstrated, in the venous phase, a distinctly different lesion.

Splenic vein (SV) thrombosis (in the non-OLT setting) has been reported most commonly in association with the inflammatory processes of acute or chronic pancreatitis or pancreatic cancer (*13–17*). Other etiologies have included sclerotherapy, trauma, erosion of benign gastric ulcers, lymphoma, retroperitoneal fibrosis, and myeloproliferative disorders (*16, 18, 19*). Patients with these conditions usually present with splenomegaly and UGI bleeding, although some are asymptomatic. Liver

* Abbreviations: CHA, common hepatic artery; CV, coronary vein; IVC, inferior vena cava; PEEP, positive end expiratory pressure; PV, portal vein; SV, splenic vein; US, ultrasound.

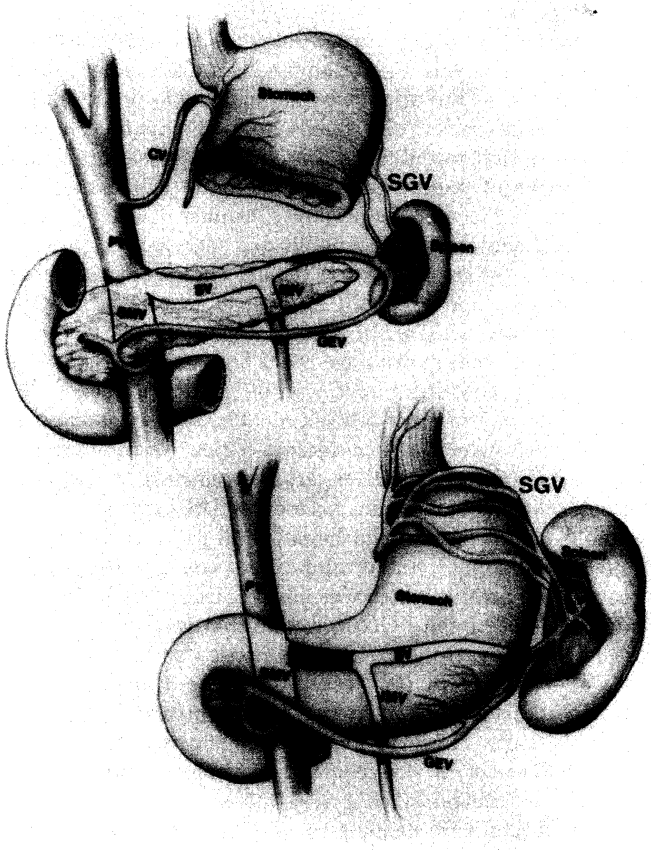

FIGURE 1. Upper panel demonstrates normal portosplenic venous anatomy. Lower panel demonstrates central splenic vein thrombosis in this patient. Venous flow from the spleen is through the short gastric vessels (SGV), gastroepiploic vein (GEV), and the inferior mesenteric vein (IMV). The portal vein (PV) is patent. The coronary vein (CV) was not visualized.

function is normal, and, as in our case, esophageal and gastric varices are not usually seen, although thickened gastric folds may be noted on endoscopy (*15, 16*). The diagnosis is best made radiographically (*15, 16, 20*). Doppler/US of OLT recipients is useful as a screen (*21*), although arteriography, and particularly the venous phase, unequivocally establishes the diagnosis of splenic vein thrombosis (*3, 22*). Depending on the drainage of the coronary vein, there may or may not be esophageal varices in addition to the gastric varices. If the coronary vein (CV) drains into the portal vein (24%) then the esophageal veins can be decompressed. If the CV drains into the SV (17%), the esophageal veins will not be decompressed and can develop into varices. In 59% of cases, the CV drains into the confluence of the PV/SV, and decompression of the esophageal vein then depends on the extent of the SV thrombosis (*15*). In our case, gastric varices were noted on venous phase angiography, the PV was patent, the CV was not seen, and the central aspect of the splenic vein was thrombosed (Fig. 1).

In this case, the biliary anastomotic breakdown resulted in an abscess in the lesser sac, contiguous with the pancreas. Although there was no evidence of pancreatitis by serial amylase determinations or CT scan of the abdomen, it is possible that inflammation in this area resulted in SV thrombosis (*15*). Similarly, electrocautery of the bleeding site on the lesser curve of the stomach may have predisposed to SV thrombosis by virtue of proximity. However, only one week later considerable gastric varices were apparent by angiography, and this time course is probably too rapid. There is one description of hepatic artery thrombosis due to acute pancreatitis after OLT, but there is no mention of SV thrombosis or UGI bleeding (*23*). Furthermore, reports of bile duct leaks (*1, 2, 24–27*), or pancreatitis (*24, 28*), following OLT have not described SV thrombosis or gastric variceal bleeding as complications. There is some evidence that a coagulopathy occurring with a high incidence in children following OLT, due to a deficiency of protein C, predisposes to a high rate of PV thrombosis (*29*). However, protein C levels were noted to be normal in this patient.

In this case, as well as in the non-OLT setting, splenectomy is curative for gastric variceal bleeding secondary to SV thrombosis (*15, 16*). Gastrotomy and oversewing of varices are advised if there is active bleeding at the time of surgery (*15*). The splenectomy can be technically challenging with significant blood loss (*15*).

In the setting of OLT, where bile leaks are not uncommon, and many factors influence liver function and coagulation, the development of massive variceal bleeding should prompt angiographic study to differentiate PV from SV thrombosis. Isolated SV thrombosis, as in our case, can be treated with splenectomy, with or without gastrotomy, and oversewing of bleeding vessels, while PV thrombosis, requires significantly different therapy (*6*).

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