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Postoperative Surgical Complications

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The results of liver transplantation have dramatically improved since the introduction of cyclosporine in 1978. A 1-year survival rate of 70 per cent is universally expected now instead of the 30 per cent survival rate seen consistently in the precyclosporine era.[1] Five-year survival rates of 55 to 60 per cent are also expected, whereas prior to the introduction of cyclosporine rates were only 18 per cent.[2] With this overall improvement in survival, liver transplantation has become a widely accepted form of therapy for all endstage liver disease and for some forms of metabolic liver disease. Most deaths (80 per cent) occur within the first 3 postoperative months.[1] Advances in operative technique, venovenous bypass without heparin, and refinements in anesthesia have made intraoperative fatalities uncommon. However, the early postoperative course following a liver transplant is still beset with numerous surgical complications. Attention to the early detection and management of these complications decreases morbidity and mortality. In this article we will discuss the surgical complications that liver transplant recipients are subject to in the immediate postoperative period. The following complications will be considered: intra-abdominal bleeding, vascular, biliary, intestinal complications, intra-abdominal sepsis, wound complications, complications from liver biopsy, and pancreatitis.

One should note that this division of complications is arbitrary. They are so intertwined that a given patient may have two or three of them in sequence or they may occur together. Table 1 illustrates the incidence and importance of some of these complications.

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Table 1. *Technical Complications in 393 Orthotopic Liver Transplants*

Complications	Grafts (393	Patients (313	RETRANSPLANTATION		DEATHS	
			Successful	Failed	Unrelated	Related
iliary tract	52 (13.2%)	52 (16.6%)	3	1	2	5 (9.6%)
Hepatic artery thrombosis	27 (6.8%)	25 (7.9%)	10	6	—	16 (64.0%)
Portal vein thrombosis	6 (1.5%)	6 (1.9%)	—	1	1	2 (40.0%)
Portal vein stenosis	2 (0.5%)	2 (0.6%)	—	—	—	—
Portal vein and inferior vena cava thrombosis	1 (0.3%)	1 (0.3%)	1	—	—	—
nferior vena cava thrombosis	2 (0.5%)	2 (0.6%)	—	1	1	1 (50.0%)
Total	87 (22.1%)	85 (27.1%)	14	11	6	24 (7.6%)

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INTRAABDOMINAL BLEEDING

Early Postoperative Bleeding

Following liver transplant there is a high potential for postoperative bleeding. Numerous raw peritoneal surfaces and vascular anastomoses have been created. A well-functioning allograft with its synthesis of coagulation factors will take care of the oozing from most of these areas. Routinely three Jackson Pratt drains are inserted at the end of surgery to monitor the amount of postoperative drainage. Most of the drainage is serosanguinous ascitic fluid. A hematocrit of this fluid should be obtained if it appears excessively bloody, and it should be compared with the patient's hematocrit.

The highest risk of bleeding occurs within the first 48 hours following transplant. If the patient exhibits hemodynamic instability or requires five or more units of packed red cells (arbitrary) in 24 hours, re-exploration and control of bleeding is recommended. When postoperative bleeding occurs in a setting of marginal allograft function, it is prudent to wait for 3 to 4 days to allow allograft function to improve, if the patient can be maintained hemodynamically stable with transfusions. In our program, in a 6-month period (January 1987—June 1987) 7 per cent of patients (5.3 per cent of transplants) required a reexploration for intraabdominal bleeding (unpublished data).

At reexploration, the bleeding could be from any of the vascular anastomoses, triangular ligament areas, retroperitoneal areas behind the liver and drain sites, to name a few possibilities. Occasionally the bleeding is from the allograft (liver lacerations, gall bladder bed, and small branches of the donor vessels). Not uncommonly, during exploration all that is found are large amounts of clots with no specific bleeding source. If allograft function is poor, bleeding becomes a serious operative problem and prolongs the original surgery by several hours and, more frequently, necessitates reexploration in the early postoperative period. We have seen a few patients develop intraabdominal bleeding 3 or 4 days after the transplant when they have been placed on antiplatelet agents (Dextran, aspirin, and Dipyridamole).

In patients who have experienced abdominal bleeding that has not been serious enough to require exploration, an abdominal CT scan is recommended to detect retained clots. If major clots are identified, an operation to evacuate them is recommended to prevent secondary infection.

Late Postoperative Bleeding

In the late postoperative period, patients can develop abdominal bleeding from a percutaneous liver biopsy and percutaneous biliary tract procedures. Occasionally these require laparotomy to control the bleeding (see under liver biopsy). In the presence of severe abdominal sepsis, sudden massive intraabdominal bleeding can occur from disruption of an arterial or portal anastomosis. Control of these is extremely difficult, often requiring vascular grafting or vessel ligation. The prognosis in these cases is very poor.

VASCULAR COMPLICATIONS

Portal Vein

The specific complications related to portal vein are thrombosis, stenosis, and fistulous communications with the biliary or arterial systems. When portal vein thrombosis occurs in the early postoperative course, it has very serious consequences.[4] It usually results in severe allograft dysfunction and variceal bleeding (in those with preexisting varices). Oliguria, hemodynamic instability, and a clinical picture of respiratory distress syndrome can occur. When portal vein thrombosis occurs late, it invariably manifests with variceal bleeds and splenomegaly. Allograft liver function continues to be good in these later cases. Fortunately the complication of portal vein thrombosis is rare. In two series reported from our institution, the occurrence of portal vein thrombosis ranged from 1.9 to 2.2 per cent.[4,5] In the immediate posttransplant period, if allograft function is poor, it is crucial to ascertain the patency of all vascular anastomoses by Doppler ultrasound. If there is any indication of portal vein thrombosis, arteriography is strongly recommended (Fig. 1). The following are factors contributing to portal vein thrombosis.

Poor Inflow. This could result from a hypoplastic portal vein. Previous portosystemic shunts and operations in the hilum of the liver (Kasai procedure in children) produce an involution in the size of the portal vein.[4] Also large portosystemic collaterals (coronary vein) can cause a "steal phenomenon" and reduce portal venous flow. Some recipients have complete portal vein thrombosis. In these cases, it is imperative to improve the inflow by various means (thrombectomy and/or bridge vein grafts).[5]

Technical Factors. Redundancy of the portal vein and torsion or stenosis at the anastomosis predispose to thrombosis. When thrombosis occurs in the first several days after transplant, emergency portal vein thrombectomy is indicated if the diagnosis can be made within a few hours of onset. We have been successful in salvaging a patient by performing this procedure combined with an interposition vein graft. When portal vein thrombosis occurs late in the postoperative period, several hepatopetal collaterals can be demonstrated by angiography.[4] Because allograft liver function is usually good, it is prudent to manage the varices either by sclerotherapy or a splenorenal shunt. Retransplantation is considered only if portal vein thrombosis is associated with other causes of severe allograft dysfunction.

Arterial Complications

Hepatic artery thrombosis is the second most common serious surgical complication following liver transplantation.[6] If we were to consider only the pediatric recipients, it is the most frequent and serious complication (Fig. 2). In an allograft liver, the hepatic artery is an end artery. All existing collateral vessels in the many peritoneal attachments to the liver are transected during the donor hepatectomy. The extrahepatic biliary tree in humans is nourished by a vascular plexus into which small arteries feed both from the duodenum below (retroduodenal and retroportal arteries)

Figure 1. Portal vein thrombosis. Occlusion of extrahepatic portal vein (*straight arrow*) demonstrated on venous phase of superior mesenteric arteriogram. There is severe portal hypertension as evidenced by gastric varices (*curved arrow*) and retrograde flow in splenic (*small arrowhead*) and inferior mesenteric (*large arrowhead*) veins.

biliary tree is supplied by branches of the hepatic arteries. In the allograft situation, the segment of the donor extrahepatic bile duct retained depends solely on descending branches from the hilum for its blood supply. Herein lies one of the unique susceptibilities of the biliary system to arterial thrombosis of the allograft. The following are causative factors involved in hepatic artery thrombosis.

Poor Inflow. This can occur in elderly recipients because of atherosclerotic disease in the celiac axis. When the recipient liver has multiple aberrant hepatic arteries, the celiac axis may provide insufficient inflow. In these cases, a vascular graft should be placed between the recipient infrarenal abdominal aorta and the donor hepatic artery. An alternative is to use the celiac trunk of the recipient at, or proximal to, the origin of the splenic and left gastric arteries (refer to "Surgical Technique of Orthotopic Liver Transplantation").

Technical Factors. Intimal dissection, either in the donor or recipient artery, can cause thrombosis. Whether excessive redundancy causes arterial thrombosis is questionable. Prolonged postoperative hypotension secondary to sepsis or bleeding has caused arterial thrombosis in a few patients. The role of increased outflow resistance caused by a swollen liver secondary to

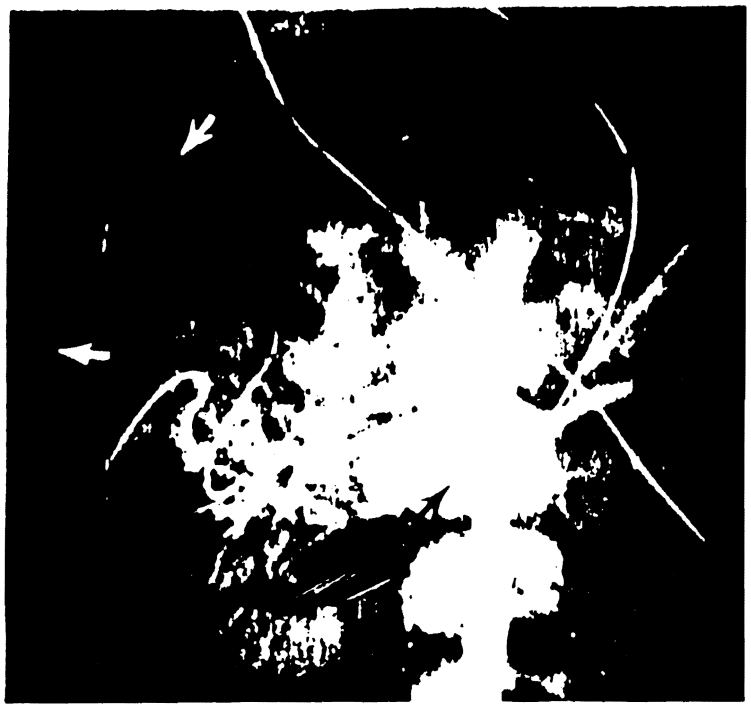

Figure 2 Massive hepatic infarction following thrombosis of allograft hepatic artery. Abdominal aortogram shows occlusion of iliac homograft (*black arrow*) and large gas-filled hepatic infarct. Gas is also present within intrahepatic portal veins (*white arrows*).

The spectrum of clinical presentation of hepatic artery thrombosis varies from septic shock secondary to fulminant hepatic gangrene to being asymptomatic, at least temporarily.[5,9] In patients developing hepatic gangrene, there is sudden onset of fever, hypotension, respiratory distress with gram-negative and anaerobic sepsis. Plain abdominal x-rays often reveal gas diffusely in the liver (see Figure 2). The only chance for survival for these patients is urgent retransplantation. The more common presentation is fever occurring a few days after transplantation. The transaminases increase over their previous values. The bilirubin level may or may not change. Blood cultures frequently grow enteric organisms.

A postoperative biliary leak, especially in children, should make one suspicious of the diagnosis of hepatic artery thrombosis. In these patients, the extrahepatic bile duct undergoes necrosis and leaks. The initial test to be done is a real-time ultrasound with Doppler screening. Ultrasound in this form has been proven to be a very sensitive screening test for hepatic arterial patency.[10] Without Doppler studies it is easy to mistake transmitted pulsations from neighboring vessels as evidence of patency of the hepatic artery. Arteriography is recommended to confirm the diagnosis of occlusion. CT scanning very often demonstrates a hypodense lesion that is (1) a hepatic parenchymal infarct, (2) a nonanastomotic biliary leak (bilomas); and (3) lobar biliary collections. The biliary complications these patients develop are well described in a recent paper by Zajko and colleagues.[11]

Management. Because of high incidence of sepsis with enteric organisms, these patients need to be started on effective antibiotic therapy (a third-generation cephalosporin and ampicillin is a good starting choice). If the sepsis does not respond in 10 to 14 days, an attempt must be made to drain the collections (hilar and intrahepatic) percutaneously. These attempts may require placement of more than one catheter. Initially the fluid drained is chocolate brown in color but frequently it turns bilious in a few days. Appropriate cultures of this fluid should be obtained.

Except in a situation of frank intraperitoneal biliary leak, restraint should be exercised in performing an abdominal exploration in these patients because of the following: the liver is very friable; it is impossible to drain the multiple intrahepatic collections surgically; and the precarious collaterals that are establishing can be damaged. Once the acute situation of systemic sepsis is controlled, these patients face long-term consequences, which are multiple biliary structures frequently at the confluence of the ducts.[11] They are often subject to recurrent episodes of cholangitis. We routinely place such patients on long-term oral prophylactic bactrim therapy.

The indications for retransplantation are the following: (1) acute fulminant hepatic gangrene; (2) inability to control systemic sepsis with parenteral antibiotics and percutaneous drainage; (3) recurrent episodes of cholangitis secondary to multiple biliary strictures. Our general policy in these frequently small patients (many of whom are less than 15 Kg) has been to control the cholangitis with antibiotics and percutaneous drainage, if necessary, and allow them to grow; then consider retransplantation.

The rare arterial complications of pseudoaneurysms and arterioportal or arteriobiliary fistulae will not be discussed.

Combined Portal and Arterial Thrombosis

Fortunately combined portal and arterial thrombosis is rare. When it occurs, it does so within the first few days following transplantation. Patients deteriorate rapidly within hours, developing encephalopathy, oliguria, hypotension, bleeding, and shock. Ultrasonography followed by arteriography will confirm the diagnosis. Urgent retransplantation is the only recourse. Even then survival is poor. We have been able to salvage only one patient with this complication. The etiological factors responsible for this combined vascular complication are obscure. In one patient there was heavy deposition of immunoglobulin and complement in the vasculature, suggesting a possible immunological mechanism analogous to hyperacute rejection in renal transplants (unpublished data).

Vena Cava Complications

Stenosis or thrombosis of the inferior vena cava is an unusual complication following liver transplantation (see Table 1).[4,6] Etiological factors are most likely to be technical errors or recurrence of Budd-Chiari syndrome. Thrombosis of the vena cava has been seen in four patients (one with a heterotopic graft). All had poor allograft function. Three out of the four died, two as a direct consequence of the complication. Retransplantation is

Table 2. *Biliary Complications Following Orthotopic Liver Transplantation*

Center	Choledochocholedochostomy without T-tube	Roux-en-Y choledochojejunostomy	Choledochocholedochostomy with internal stent	Gallbladder conduit anastomosis
Starzl et al Denver	5/9 (55%)		Cholecystoduodenostomy 17/59 (29%)	
Iwatsuki et al Pittsburgh	5/29 (17%)	2/21 (8%)	7/22 (32%)	—
Hoffman Cincinnati	12/21 (60%)	—	—	12/61 (20%)
Neuhaus et al Hannover	17/95 (18%)	5/46 (17%)	Side to side choledocho-choledochostomy 3/18 (16%)	
Kam et al Groningen	5/29 (17%)			
Lerut et al Edinburgh	20/159 (12.6%)	9/156 (5.2%)	14/32 (43.2%)	—

allograft dysfunction. Stenosis has occurred in two patients following retransplantation at the level of the original anastomosis, which had been left in place. Ascites of insidious onset is the primary symptom. Hepatomegaly and edema of the lower extremities may be present or absent. The serum bilirubin level is variably elevated along with some of various hepatic enzymes. Liver biopsy typically reveals nonspecific cholestasis although centrilobular necrosis and fibrosis may eventually ensue. A demonstrable pressure gradient can be measured across such stenosis at venography. Both of the above patients underwent venographic balloon dilatation of the stenosis with favorable results—a rapid response with a decrease in abdominal girth and a brisk diuresis within hours after the procedure occurred. However, a slow recurrence of ascites was observed in both cases over the course of several weeks and a second balloon dilatation procedure proved to be curative in one patient (the other patient developed unrelated septic complications precluding a second dilatation procedure). Ultrasonography with Doppler is an effective screening test for evaluation of vena caval problems. Angiographic visualization of the vena cava is indicated in doubtful cases.

BILIARY COMPLICATIONS

Problems related to biliary drainage have, until recently, been considered the "Achilles' heel" of liver transplantation.[12] The reason for this has been the high incidence of postoperative leakage with associated abdominal sepsis and secondary biliary obstruction, resulting in cholangitis. These episodes of cholangitis have been mistaken frequently for rejection episodes clinically, and many patients were injudiciously treated with increased amounts of immunosuppression.

The biliary tract complications from some of the published series are

avoidance of certain types of biliary drainage procedures, these complications have been reduced in number.[6, 12, 20]

Currently in our center, choledochocholedochostomy and Roux-en-Y choledochojejunostomy (Roux-en-Y CDJ) are the two methods of biliary drainage used. Both have comparable results.[6] However, the former is preferred whenever feasible because it is quicker and provides access to the biliary system by way of the T-tube during the early postoperative period (allows access to quantity and quality of bile and cholangiographic studies) and by way of endoscopic cholangiography later.

Bile Leak

Relative Ischemia of the Donor Bile Duct. It has been shown[7] that a major source of blood supply to the human bile duct is by way of small arterial branches from the gastroduodenal artery (retroduodenal and retroportal arteries) that ascend along the bile duct. These are transected during the donor hepatectomy. Hence, allograft bile duct survival depends solely on arterial branches that come from the hilum of the liver. For this reason, it is important to guarantee that too long a donor duct is not utilized at the time of the biliary anastomosis. Allograft hepatic artery thrombosis renders the donor bile duct ischemic and is associated with a high incidence of biliary leak, particularly if the thrombosis occurs within a few days following transplantation.

Technical Factors. Tension at the anastomosis, excessive dissection around the recipient's common duct injuring its blood supply, and placing too many sutures or taking large bites and devitalizing tissue are some of the technical factors that can lead to a biliary leak.

In choledochocholedochostomy, leakage can occur either at the anastomotic site or at the point of exit of the T-tube from the recipient common duct. Leaks around the T-tube exit site are not serious. If leaks are small and detected only on cholangiography, nothing needs to be done. If leaks are larger and clinically significant, the patient is explored and the site is repaired with a few additional sutures. Anastomotic leak usually manifests clinically with one or more of the following: abdominal pain; fever; leucocytosis; bilious drainage from the drains; increasing serum bilirubin; alkaline phosphatase; and gamma GTP. The diagnosis is confirmed by T-tube cholangiography and the patient is operated on immediately. Unless the leak is minor and repaired with only one or two sutures, it is wise to excise the leaking anastomosis and perform a Roux-en-Y choledochojejunostomy (Roux-en-Y CDJ).

Choledochojejunostomy. Using this method of bile duct reconstruction one does not have the luxury of access to the biliary tree by way of the T-tube. The diagnosis of a bile leak depends highly upon its clinical manifestations supplemented by a percutaneous transhepatic cholangiogram (Fig. 3). Occasionally the presence of very high bilirubin levels in the drainage fluid confirm the diagnosis without the need for percutaneous cholangiography. In most cases, bile leaks are on the anterior aspect of the biliary-enteric anastomosis. Usually the entire anastomosis needs to be taken down, the tip of Roux loop refashioned, and a new anastomosis performed.

Figure 3. Anastomotic bile leak. Contrast extravasation from the choledochojejunostomy (*arrow*) demonstrated on catheter cholangiogram.

diagnosis or when the bile duct is necrotic (secondary to arterial thrombosis), one of the following two methods of biliary drainage is utilized.

(1) Using total external drainage, the donor common hepatic duct is intubated with an appropriate sized plastic tube, retained in place with either a purse string suture around the bile duct or coapting sutures. This tube is exteriorized through the abdominal wall draining the bile externally. Once the abdominal sepsis has resolved, either a subsequent choledochojejunostomy or retransplantation is considered based on the circumstances. We have had to resort to this approach on five occasions, and we have been able to save two patients (one with retransplantation and another with a subsequent Roux-en-Y CDJ) with this approach.

(2) The second method, which is used exclusively in children, consists of trimming the common hepatic duct close to the hilum and passing a malleable probe into the duct and through the capsular surface of the lateral [illegible] 5 Fr infant feeding tube is passed

parenchyma over the malleable probe. A small opening in the antimesenteric border of the jejunum is sutured to the duct and periductal connective tissue after negotiating the feeding tube into the jejunum.

Biliary Obstruction

The second major complication related to the biliary tract occurs later in the postoperative course. The factors that lend to partial or complete biliary obstruction are similar to those that cause biliary leaks but are lesser in degree. As with biliary leaks, increasing experience and avoidance of certain biliary drainage procedures has reduced the prevalence of biliary obstruction.

Patients with biliary obstruction present as follows: (1) acute bacterial cholangitis with fever (39–40°C), chills, abdominal pain, jaundice, and bacteremia with enteric organisms; (2) relapsing episodes of mild fever (38°C) and fluctuating liver injury parameters; and (3) gradual deterioration in liver injury parameters with no associated symptoms.

Fortunately Presentations 2 and 3 are more common than Presentation 1. With an insidious onset of obstruction, the perturbations produced in liver injury parameters are frequently mistaken for an episode of rejection, hepatitis, and/or drug toxicity. Hence it is important to have a high index of suspicion and to investigate such patients in an organized manner with liver biopsy, serological tests for hepatitis, ultrasonography, and particularly cholangiography. Ultrasonography is used as an initial screening procedure. Unfortunately its false negative rate is quite high. In patients who still have an indwelling T-tube, a T-tube cholangiogram is obtained; in those without a T-tube, a percutaneous transhepatic cholangiogram is obtained (Fig. 4).[21]

Based on the cholangiographic findings, the problem is one of the following: (1) an anastomotic narrowing; (2) an anastomotic and donor distal bile duct narrowing; (3) multiple intrahepatic strictures (usually associated with arterial thrombosis); (4) dilatation of the donor and recipient common bile ducts without demonstrable obstruction (see Fig. 14, page 121); (5) obstruction due to a T-tube or internal stent; (6) unusual causes such as mucocele of the allograft cystic duct (see Fig. 12, page 119) or recurrent disease (cholangiocarcinoma, sclerosing cholangitis).[22]

In recent years at the end of the diagnostic study, an indwelling percutaneous biliary catheter has been left in patients with obstruction. This serves two purposes: it decompresses the biliary tree and thereby lessens the urgency of the situation; and if surgical treatment is decided upon, the presence of the catheter in the bile duct makes the approach to the bile duct easier. Antibiotic coverage is required for the diagnostic PTC and cyclosporine dosage readjustment after percutaneous biliary drainage is accomplished as mandatory.

Treatment. If the obstruction is localized, a trial of percutaneous balloon dilatation is utilized[23] (see "Diagnostic and Interventional Radiology in Liver Transplantation"). If this fails or the entire bile duct is dilated, surgery is required. When obstruction is associated with stones, the treatment is surgical. If the initial biliary procedure was a choledochocholedochostomy, it is converted to a Roux-en-Y CDJ whereas, in patients with a previous Roux-en-Y CDJ, it is revised. Multiple intrahepatic stric-

Figure 4. Stricture at choledochojejunostomy (*arrow*) demonstrated on catheter cholangiogram following transhepatic biliary drainage. Only a very small amount of contrast passed beyond the anastomosis into the jejunum.

tures are a difficult problem. Surgery is not used in these cases except for retransplantation. Several percutaneous biliary catheters may be required to decompress (see "Diagnostic and Interventional Radiology in Liver Transplantation") such patients and attempts at balloon dilation should be utilized prior to a retransplant.

If the obstruction is caused by a T-tube (kinking or a limb that is too long), the T-tube is removed. Some patients may require placement of a percutaneous drainage catheter at a later date. In cases where the obstruction is caused by an internal stent following a Roux-en-Y CDJ, an attempt is made to dislodge it percutaneously into jejunum (usually successful). When this fails, it must be removed surgically.

INTESTINAL COMPLICATIONS

Intestinal complications after liver transplantation can be classified into three groups: obstruction, perforation, and bleeding.

Obstruction

Intestinal obstruction following liver transplantation is somewhat rare. This is probably because adhesions following liver transplantation are confined predominantly to the supracolic compartment of the abdomen.

In patients having a Roux-en-Y choledochojejunostomy, a potential exists for internal herniation in the mesenteric rent created by jejunojejunostomy. It is advisable to close this rent. When the defunctionalized limb of jejunum obstructs, the liver injury parameters deteriorate as with any biliary obstruction. Another cause of small bowel obstruction is impaction due to inspissation of aluminum antacids (Amphojel, Alternagel). This risk is lessened by alternating the doses of magnesium- and aluminum-containing antacids. Lymphoproliferative disorders also have been shown to cause intestinal obstruction.[24]

Perforation

This intestinal complication can occur either early or late. Early perforations are usually anastomotic leaks (jejunojejunostomy and small bowel resections) or perforation of areas denuded of serosa or those injured by electrocautery. Diathermy is extensively used during liver transplant surgery and intestinal burns need to be avoided. All areas denuded of serosa should be repaired with interrupted seromuscular sutures. Anastomotic leaks are more common in children. An intestinal leak should be suspected whenever there is cloudy drainage from the abdominal drains, drainage fluid grows enteric organisms, or when there is wound or hematogenous candida infection. Prompt repair is essential for patient survival.

In patients having extensive adhesions at the time of transplant (especially children with several Kasai procedures), a routine "second look" exploration is performed within 3 to 5 days. This approach has enabled us to detect intestinal leaks and to deal with them effectively early. In rare cases with gross peritonitis and repeated anastomotic breakdown, we have had to resort to keeping the peritoneal cavity open. Late intestinal perforations are occasionally the result of a lymphoproliferative disorder.[24]

Bleeding

Bleeding can occur from anywhere along the GI tract. The diagnostic measures utilized in these patients are as in any patient presenting with GI bleeding (nasogastric tube insertion, proctoscopy, upper and lower GI endoscopy, radionuclide scans, and occasionally arteriography). Like the general surgical patient, the liver transplant recipient is subject to bleeding from stress ulceration, peptic ulcer, and angiodysplasias of colon. Some specific causes of bleeding important in liver transplant patients are discussed.

Variceal Bleeding. When this occurs, portal vein problems (thrombosis or stricture) should be suspected and appropriate tests pursued (see under Portal Vein Complications). Sclerotherapy is used as a temporizing measure.

Jejunojejunostomy. Only the subgroup of patients having a Roux-en-Y CDJ are subject to this complication. This usually manifests toward the end of the first postoperative week, but occasionally can present 2 or 3 weeks later. Its incidence appears to be similar with different kinds of suture technique. If the bleeding does not subside with expectant management, surgery is indicated. At first only the anterior half of the anastomosis is opened and the source of bleeding ascertained. Frequently the bleeding is focal. The posterior half of the anastomosis can be oversewn with a

running absorbable suture continued anteriorly that is further reinforced by an anterior row of seromuscular sutures. Less commonly, bleeding is from the suture line at the tip of the Roux loop. Another important cause of bleeding is gastrointestinal ulceration secondary to an opportunistic infection with candida, cytomegalovirus, or herpes virus. These will not be dealt with in this section. Suffice it to say that immunosuppression is either reduced or discontinued and the patient supported with transfusions. Drastic measures of total colectomy or subtotal gastrectomy may be resorted to in a life-threatening situation. An ominous and fortunately rare cause of GI bleeding is a fistulous communication between a pseudoaneurysm and the intestine or bile duct. In a patient who presented with massive lower GI bleeding caused by a pseudoaneurysm of the gastroduodenal artery communicating with the tip of a Roux loop, we were able to stop the bleeding by hepatic artery ligation. This patient is currently awaiting retransplantation because of multiple biliary strictures. In patients with long-standing indwelling biliary stents, there is a small risk of these stents eroding into neighboring vessels and causing serious bleeding.

ABDOMINAL INFECTIONS

The overall infection rate following liver transplantation is 80 per cent.[3] Infectious complications account for most postoperative deaths. Early major bacterial infection occurs in about 40 per cent of patients with a mortality of 70 per cent.[26] Clinically significant fungal infection, usually during the first month following surgery, occurs in 40 per cent of patients with a similar mortality.[27] There is considerable overlap between bacterial and fungal infections, however. Concomitant fungal infections are present in two thirds of those who die from a bacterial infection, and 80 per cent of patients with a serious fungal infection have an associated bacterial infection. About one half of candida infections can be expected to resolve with therapy, whereas aspergillus infection has been uniformly fatal. Most systemic bacterial and fungal infections arise from abdominal sepsis.[28]

Abdominal sepsis occurs in two settings—either as a result of a technical complication, such as a biliary or an intestinal leak, or denovo (presumably from external contamination or hematogenous seeding). The majority of postoperative intraperitoneal fluid collections are of ascitic fluid and resolve spontaneously. They occasionally require percutaneous aspiration to exclude sepsis. The most common locations are in the hepatorenal and the left subhepatic spaces. Similarly, small intraabdominal hematomas spontaneously resolve. However, large hematomas often become secondarily infected and lead to systemic sepsis. The most common sites for hematoma formation are the subphrenic spaces, the hepatorenal space and the left subhepatic space. True abscesses, or more commonly, infected fibrinous exudative collections also have a predilection for these spaces.

Liver transplant patients with abdominal sepsis have varied clinical presentations. Fever (37°C) is the most common presentation. Any febrile episode in these patients should be investigated aggressively. Hyperbilirubinemia not caused by rejection, biliary obstruction, or transfusions

should also alert one to the possibility of sepsis. Leucocytosis is an unreliable sign of sepsis, and hypotension and mental status changes are later events.

Ultrasonography (US) and computerized tomography (CT) are the key diagnostic tools. Each has limitations, and either one may be superior to the other in a given circumstance. The presence of ileus with gas-filled loops of bowel or an open abdominal wound limits the value of ultrasonography. Hemodynamic instability and a requirement for high positive end expiratory pressure (PEEP) makes transportation to a CT unit unsafe. A diagnostic laparotomy may be required in difficult cases. The morbidity of a negative laparotomy is minimal, and one should not be hesitant to explore the patient if the suspicion of sepsis is strong and all other diagnostic studies have been negative. Radio-labelled leucocyte scans have been found to be unreliable.

The organisms usually responsible for sepsis in a liver transplant recipient are gram-negative enteric organisms, enterococcus, or candida. The presence of yeast either in the abdominal wound or in the drainage fluid should alert one to the possibility of either a visceral perforation or a biliary leak.

Initially, broad-spectrum antibiotics are started whenever sepsis is considered likely, until culture and sensitivity reports are available (third-generation cephalosporin and ampicillin or a new semisynthetic penicillin with an aminoglycoside are good starting choices). The prevailing bacteriological spectrum in a given hospital also dictates these choices. Antibiotics are only of temporary value, and the infective source should be aggressively identified and drained. If one waits to see whether the patient improves, the tide often turns toward the long downhill path of multiorgan failure and refractory sepsis. It is important to remember that infected collections around vascular anastomoses are associated with the danger of an anastomotic rupture and fatal hemorrhage.

In some patients, improvement following drainage of a septic focus in the abdomen is temporary, and they require subsequent laparotomies to drain reaccumulating purulent collections. Reoperation following surgical drainage of an intraabdominal abscess is associated with a perioperative mortality rate of 30 to 50 per cent.[29] This poor outcome has not improved despite advances in critical care support, noninvasive imaging, and the use of broad-spectrum antibiotics. As a result, various modalities have been advocated in the treatment of recurrent abdominal sepsis, some of which include a second-look "scheduled" laparotomy, continuous peritoneal lavage, and leaving the abdomen open.[30–32] Repeated laparotomies take their toll on the patient and often lead to further deterioration instead of improvement. As a result, one option occasionally utilized is leaving the abdominal cavity open following surgical drainage and irrigation. Daily "laparotomies" and extensive irrigation of the abdominal cavity are performed by the surgical staff using sterile technique at the bedside in the ICU. In addition to providing frequent interval "washout" of any recurrent infection, this method gives the surgeon an opportunity to inspect and examine the intraabdominal contents on a daily basis. Disorders or complications requiring intraoperative procedures may be diagnosed early, allowing less delay in therapy. If the infection resolves, the open wound will

heal secondarily over the course of several months. Skin grafting is not usually required. Although the mortality rate is high, some patients have been salvaged using this method.

WOUND COMPLICATIONS

Wound complications occur in 10 per cent of patients and consist primarily of hematomas and infection.[25] In liver transplant patients there are several risk factors that increase the likelihood of wound hematoma formation. Preexisting coagulation abnormalities, numerous portosystemic venous collaterals in the abdominal wall, the large amount of blood transfusions given, and poor allograft function are some of these factors. In addition, the use of antiplatelet agents may play a role. Evacuation is the most prudent approach to the management of a wound hematoma. Needle aspiration may be attempted, although direct evacuation by opening the skin incision is usually required. Persistent wound hematomas may lead to superficial and deep infections of the wound.

Wound infections are related directly to duration of preoperative hospitalization, prolonged intraoperative exposure time, faulty hemostasis, steroids, and bacterial contamination.[26] These risk factors are magnified in liver transplant surgery. Candidates awaiting liver transplant often require prolonged hospitalization for management of the complications of their chronic liver disease. The operation is one of the longest. Blood, the best culture medium, is always plentiful. The abdomen is contaminated with bile, and intestinal anastomoses are often required. Worse yet, the classic signs of inflammation are usually masked, if not absent, because of the use of steroids. Needle aspiration is indicated with any suspicion of a wound infection, and if any question remains, the wound should be opened at the bedside using sterile technique and with appropriate cultures being taken. The wound should be left open to heal secondarily. Intravenous antibiotics are selected based on the sensitivities of organisms cultured from the wound. The growth of yeast from a wound should alert the physician to the possibility of intraabdominal sepsis, either from a leaking biliary or intestinal anastomosis or from a perforation. In all such cases appropriate investigations must be pursued vigorously, including possible diagnostic laparotomy if all other modalities are unrevealing.

Occasionally, a patient experiences a necrotizing fasciitis of the abdominal wound. This rapidly progressive, highly lethal infectious process consists of polymicrobial invasion of the tissue. Underlying muscle is typically spared and the superficial wound may appear deceptively benign. However, tenderness is prominent and is accompanied by an obvious systemic toxicity. Early recognition and extensive surgical debridement of all necrotic and infected tissue is mandatory. Broad-spectrum antibiotics are selected because of the wide variety of organisms cultured in these cases (streptococci, staphylococci, gram-negative rods, and anaerobes).[11,47] In addition, antifungal coverage (amphotericin B) should be utilized in these patients. Successful treatment results in a large ventral hernia that will eventually require correction.

Occasionally the tension is too great to approximate the fascial margins of the abdominal wound at the end of the transplant operation. The defect in the wound must then be patched with an artificial temporary cover such as Marlex or silastic. Too large a donor liver for a given recipient, prolonged clamping of the recipient portal vein, and an extremely prolonged procedure are several of the factors responsible for this situation. Postoperatively, the wound should be dressed with sterile gauze at the bedside at least daily. Usually the patient is returned to the operating room within a few days, at which time the abdomen is closed without difficulty. If definitive wound closure is delayed for more than a few days, the surgeon may encounter considerable difficulty in attempting to approximate the wound margins.

Axillary and groin incisions used for venovenous bypass are also subject to complications occurring in about 25 per cent of patients.[26] Most are minor. Because of the richness of lymphatic vessels surrounding the saphenous and axillary veins, lymphoceles are a common occurrence. These resolve eventually, but may require periodic aspiration or even drainage. As these incisions are located in intertriginous areas and have prolonged operative exposures, superficial wound infection and breakdown is quite common. Upper and lower extremity edema can occur due to either axillary vein ligation or thrombosis and long saphenous vein ligation. A brachial plexus injury is rare but can occur.

COMPLICATIONS OF LIVER BIOPSY

"Routine" postoperative liver biopsies are not performed in our center. Liver biopsies are obtained whenever there is doubt regarding the etiology of allograft dysfunction. Accurate assessment of any allograft dysfunction is essential to avoid serious consequences of misdirected management. Laboratory tests and imaging studies are often nonspecific and lack sensitivity. Liver transplant patients require usually one or more liver biopsies after surgery.

The technique of percutaneous needle biopsy of the liver is familiar to most gastroenterologists.[39] Pediatric patients should be sedated for the procedure. The hematocrit should be at least 25 per cent. Prior to the procedure, thrombocytopenia (platelet count less than 50,000) and coagulopathy (prothrombin time greater than 20) are corrected with transfusions of platelets and fresh frozen plasma. Right-sided pulmonary disease, a pleural effusion, mechanical ventilation, and ascites are not considered contraindications to liver biopsy in transplant patients. The biopsy is performed using a Menghini type of needle through a midaxillary intercostal approach.

Complications include pneumothorax, hemothorax, intraperitoneal bleeding, intrahepatic or subcapsular hematoma, bacteremia and pseudoaneurysm of an intrahepatic artery (see Fig 23, page 130). Hemothorax can occur from either an intercostal vessel, the diaphragm, or a pulmonary injury. Sources of intraperitoneal bleeding include the liver, the diaphragm, and an intercostal vessel. The biopsy site must be far enough cephalad in the midaxillary line to avoid puncture of the hepatic flexure of the colon.[40]

The mortality rate in two large comparable series involving more than 100 000 biopsies using the Menghini needle has been 1:6000.[41] The safety of liver biopsy has been maintained in liver transplant recipients.[42] An occasional nontatal bleeding complication requires laparotomy or thoracotomy. The recently described technique[43] of leaving a small fascial "window" open for direct-vision needle biopsy of the left lobe of the liver through the subxiphoid portion of the wound appears to offer no additional advantages over closed-liver biopsies in these patients.

PANCREATITIS

Clinically significant pancreatitis following liver transplantation is a relatively uncommon occurrence. More often patients are found to have a mild ileus with moderate elevation of serum amylase (< 500 IU/dl) in the initial postoperative period. The paucity of symptoms and nearly universal recovery suggest that benign transient amylasemia may be related to intraoperative manipulation of the pancreas rather than a genuine pancreatitis. Some patients develop edema and enlargement of the pancreas demonstrated with CT or US imaging, which is associated with hyperamylasemia. These patients are usually treated cautiously with slow advancement of their diet for fear of precipitating a more severe episode of acute pancreatitis. Two clinical situations that may increase the risk as a result of excessive intraoperative manipulation of the pancreas include portal vein grafts and aortohepatic arterial grafts, both of which require considerable dissection behind the pancreas. These patients should be observed for the occurrence of pseudocyst and abscess. Fortunately pancreatitis following aortic or portal graft construction is not often severe and has a favorable prognosis. When hemorrhagic or necrotizing pancreatitis occurs perioperatively, survival has been poor and is usually associated with HBs antigenemia.

SPLENIC COMPLICATIONS

A large percentage of patients with end-stage liver disease have splenomegaly. Some of these patients develop splenic infarcts before transplantation. When the splenic artery in the recipient is ligated to gain access to the celiac trunk for the arterial anastomosis, splenic infarcts almost always occur (Fig. 5). These are usually asymptomatic, associated with leucocytosis and can be demonstrated on abdominal CT scans. Nothing needs to be done for these infarcts. However, in patients with a febrile course in whom an exhaustive search has revealed no other cause for the fever and if a course of antibiotics has not controlled the fever, splenectomy is required. These patients will subsequently require protection against further infections with capsulated organisms.

Chylous Ascites

This is a rare complication. It occurs in patients who have either

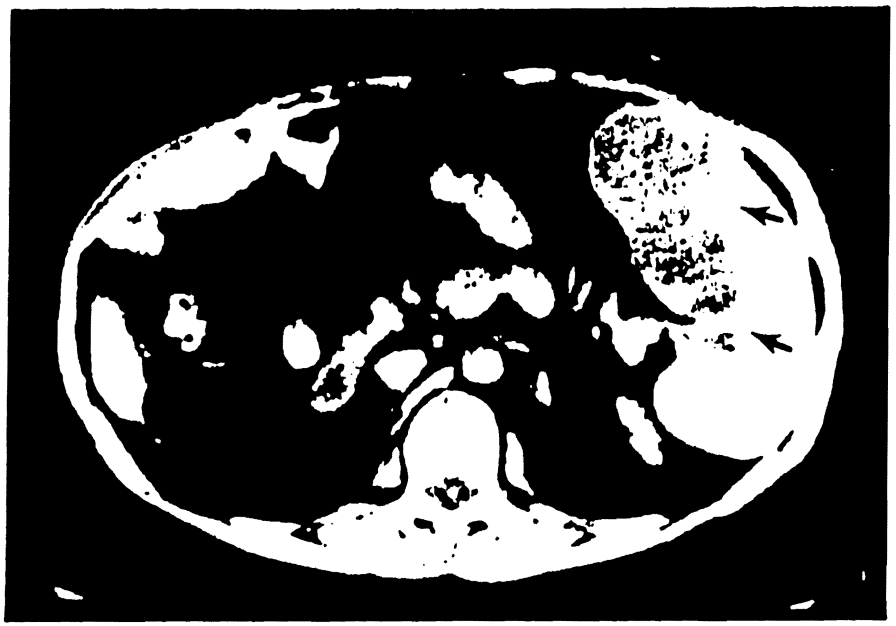

Figure 5. CT scan of abdomen demonstrating splenic infarcts in a patient who required splenic artery ligation at the time of transplant. Patient developed fever and left upper quadrant pain that responded to a course of antibiotics without needing splenectomy.

celiac axis, or in patients who have required an arterial graft from the infrarenal abdominal aorta. This presents as milky drainage in the abdominal drains. It usually resolves within a few days. However, one of our recent patients continued to have this problem for several weeks and required total parenteral nutrition to resolve the problem.

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