# Interventional and Surgical Techniques in Solid Organ Transplantation

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**KEYWORDS**

• Liver transplantation • Kidney transplantation • Pancreas transplantation • Surgical techniques • Complications and interventions

**KEY POINTS**

- The most commonly used methods and techniques for solid organ transplantation are reviewed in this article. Attention is given to the surgical technique and rationale for each anastomosis, with a discussion of commonly encountered post transplant complications.
- Vascular complications after solid organ transplantation include stenosis, thrombosis, or occlusion and can involve the arterial and/or venous structures.
- Interventional therapy used to treat both vascular and nonvascular (eg, biliary duct or ureteral) complications include thrombolysis, angioplasty, and stent or catheter placement.

## SURGICAL TECHNIQUES IN SOLID ORGAN TRANSPLANTATION

### *Liver Transplantation*

Since the pioneering times, innumerable improvements have been made that have transformed the modern liver transplant procedure from an experimental undertaking to a therapeutic and lifesaving procedure. Included in these improvements are the evolution of anesthesia techniques, the introduction of electrocautery and hemostatic agents, the contribution of venovenous bypass to provide more hemodynamic stability and a more suitable atmosphere for the education of liver transplant trainees, and the use of modern mechanical retractors that permit an unrestricted exposure of the surgical field.

#### *Transplant techniques*

Liver transplantation is now typically performed using one of two different techniques and is based on the anastomosis of the inferior vena cava (IVC)[1]:

- The classic technique using vena cava interposition
- The piggyback technique, which leaves the native cava behind

There are several potential advantages of the piggyback technique[1]:

- Partial and transient clamping of the IVC maintains continuity of the IVC during the anhepatic phase, minimizing hemodynamic disturbances
- Decrease in warm ischemia time because of the need for only one caval anastomosis
- Decreased retroperitoneal dissection, potentially decreasing blood loss
- Preservation of the native IVC allows adjustment of vessel size disparity between the donor and recipient when the donor liver is small

#### *Venovenous bypass*

Venovenous bypass can be performed during liver transplantation (typically with the classic

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technique), and is the extracorporeal circulation of blood from the venous system, typically from the portal and femoral veins, with a return of blood from the circuit to the central veins, usually via an axillary or internal jugular vein.[2]

Potential advantages for venovenous bypass[3,4]:

- Preservation of cardiac, pulmonary, renal, and cerebral blood flow (especially important in patients with fulminant hepatic failure)
- Maintenance of hemodynamic stability during the anhepatic phase
- Reduction of intraoperative blood loss

Potential disadvantages for the use of venovenous bypass include[3–6]:

- Pulmonary or air embolus
- Longer operative and warm ischemia times
- Increased bleeding caused by hemolysis and fibrinolysis in the bypass circuit
- Higher procedural cost
- Lack of clear evidence showing improved clinical outcomes

Controversy still exists over the use of venovenous bypass. Most centers believe that its routine use is no longer necessary for either surgical technique.[2]

**Surgical technique for orthotopic liver transplantation** Successful organ engraftment begins with a controlled recipient hepatectomy. This hepatectomy can be a challenging task in individuals with prior upper abdominal surgery or in patients with severe portal hypertension and extensive collateral formation. The abdomen is opened via a bilateral subcostal incision with midline extension, termed a Mercedes incision. A mechanical retractor is placed with the blades under both costal margins to pull the rib cage laterally and anteriorly.

### Surgical steps for recipient hepatectomy

1. The falciform ligament is divided down to the suprahepatic vena cava and the round ligament is tied, given frequent recanalization of the umbilical vein in patients with portal hypertension.
2. The left triangular ligament is then opened with cautery followed by opening of the gastrohepatic ligament. The ligated round ligament is now lifted superiorly to allow visualization of the porta hepatis.
3. Dissection is then carried down to the hepatic artery, which is then divided above its bifurcation.
4. The common bile duct is then divided. Once the bile duct is divided, the dissection is completed around the portal vein and the right triangular ligament is dissected into the right hepatic vein. The portal vein is then transected above its bifurcation using mechanical staplers.
5. The anterior aspect of the infrahepatic IVC is then exposed to allow easy circumferential mobilization for placement of a vascular clamp. The retrohepatic caval tissue can be dissected with the surgeon's finger.

At this point in the operation, the patient is prepared for venovenous bypass (if used) by cannulation of the femoral vein using a 15-F cannula. The return cannula is inserted into the left axillary vein or internal jugular vein using an 18-F or 12-F cannula, respectively. In addition, a 28-F cannula is introduced in the portal vein. Bypass can then be commenced. After initiation of bypass, vascular clamps are placed on the suprahepatic and infrahepatic IVC and the IVC is divided proximally and distally. The native liver is then removed. The donor liver is now brought onto the surgical field. When performing the classic technique, the suprahepatic IVC is first anastomosed, followed by the infrahepatic IVC (**Fig. 1**).

When performing the piggyback technique, venovenous bypass is almost never needed and a partial clamping of the suprahepatic IVC is performed (**Fig. 2**). The right, middle, and left hepatic veins are then divided as far into the liver as possible, so that the 3 hepatic veins can be connected into a common cloaca. The donor suprahepatic vena cava is anastomosed to the recipient common cloaca in an end-to-side fashion. The donor infrahepatic IVC is closed with a stapler during bench preparation, creating an IVC stump (**Fig. 3**).

### Surgical steps for donor graft placement after inferior vena cava anastomosis

1. After the IVC anastomosis has been made, the portal anastomosis is created.[7]
   a. The time period to complete the caval and portal vein anastomoses before reperfusion (the warm ischemia time) ideally should not exceed 45 minutes.
   b. If venovenous bypass was used, then the portal bypass cannula is now removed and only the systemic venovenous bypass is continued. After reperfusion of the liver, the systemic bypass can be discontinued.
   c. When the portal vein is unsuitable for anastomosis because of significant thrombosis, a conduit using donor iliac vein is created to anastomose with the recipient superior mesenteric vein and the donor portal vein.