Liver Transplantation With Renoportal Anastomosis After Distal Splenorenal Shunt

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Background: The distal splenorenal shunt (DSRS) is designed to maintain hepatopetal portal vein flow while decompressing gastroesophageal varices. However, over time, as the underlying liver disease progresses, the DSRS loses its selectivity. The most common method of addressing this issue during orthotopic liver transplantation is shunt ligation with or without splenectomy. Dismantling the shunt increases the complexity of the transplantation, and splenectomy may increase the risk of infection.

Hypothesis: Anastomosis of the donor portal vein to the left renal vein without dismantling the shunt is an effective method of portal vein reconstruction for patients with a patent DSRS.

Design: Retrospective analysis.

Setting: University-based teaching hospital, Miami, Fla.

Patients: Five liver transplant recipients with patent DSRS who received an orthotopic liver transplant between September 1996 and August 1999.

Interventions: The donor portal vein was anastomosed end-to-end to the left renal vein during liver transplantation.

Main Outcome Measures: Perioperative morbidity, portal vein flow by Doppler study, patient survival, and graft survival.

Results: In all patients, the graft liver reperfused promptly via flow through the left renal vein with adequate decompression of the bowel. Normal portal venous flow was demonstrated by intraoperative and postoperative Doppler ultrasound studies. At the mean follow-up of 16 months, 4 patients were alive with well-functioning grafts.

Conclusions: This novel technique has the advantage of decreasing the complexity of the procedure, without requiring splenectomy, while securing adequate portal perfusion. Additionally, it can be applied without modifications in patients with portal vein thrombosis.


Although endoscopic therapy and the transjugular intrahepatic portosystemic shunt have superseded the role of surgery in the management of portal hypertension, surgical shunt procedures are still a desirable option for selected patients. Compared with other nonselective surgical shunt procedures, the distal splenorenal shunt (DSRS) is widely used because it offers a low incidence of hepatic encephalopathy and hepatic decompensation. Despite successful portal decompression by DSRS, some patients may require subsequent orthotopic liver transplantation (OLT) when their liver disease progresses to hepatic failure.

The DSRS is designed to maintain hepatopetal portal vein flow while decompressing the gastroesophageal varices. With time, the shunt can lose selectivity as pancreatic and retroperitoneal collaterals develop. At the time of OLT, portal vein flow may have reversed or portal vein thrombosis may have developed. Therefore, most of the previously described surgical techniques for OLT in patients with patent DSRSs interrupt the shunt because flow to the portal vein may be decreased if the shunt is left intact. The dismantling procedure is typically performed by directly ligating the shunt during the splenectomy, and it can markedly increase the complexity of OLT. Furthermore, a splenectomy may increase the risk of infection after OLT.

We hypothesized that anastomosis of the donor portal vein to the left renal vein without dismantling the shunt is an effective method of portal vein reconstruction for patients with patent DSRSs who are undergoing OLT.
RESULTS

Between September 1996 and August 1999, left renal vein to portal vein anastomosis was performed in 5 patients (2 men and 3 women) with patent distal splenorenal shunts. The mean patient age was 53 years (range, 44-66 years). The causes of hepatic cirrhosis were hepatic C virus infection (n=3), primary sclerosing cholangitis (n=1), and cryptogenic cirrhosis (n=1). Each patient had 1 to 6 episodes of variceal bleeding before the DSRS procedure. All DSRSs had been performed uneventfully; none of the patients experienced recurrent bleeding. The interval between DSRS and OLT ranged from 11 months to 7 years (median, 3.8 years). In each patient, the pat-

cency of the DSRS was confirmed by pretransplant Doppler ultrasound study.

All 5 patients received ABO-identical, size-matched liver grafts. The average donor age was 44.4 years (range, 16-67 years). Cold ischemia time ranged from 4 hours 45 minutes to 11 hours 38 minutes, and warm ischemia time ranged from 26 minutes to 67 minutes.

Doppler ultrasound evaluation before OLT showed reversed portal vein flow (hepatofugal flow) (n=3), portal vein thrombosis (n=1), and extremely small portal vein and normal direction of flow (n=1). Angiography was performed in 3 patients, demonstrating patent DSRSs with excellent flow. Portal vein thrombosis was discovered during the procedure of 1 patient whose pretransplantation angiogram had shown patent but hepatofugal portal flow (Table 1).

The graft livers reperfused promptly in all patients. Intraoperative and postoperative Doppler ultrasounds

METHODS

Data were retrospectively collected on 5 patients with prior DSRSs who underwent OLT with the left renal vein to the donor portal vein anastomosis between September 1996 and August 1999 at our institution. Data included patient age and sex, causes of cirrhosis, history of DSRS, donor ages, postoperative course, and findings at follow-up.

After the hilar dissection (during which the hepatic artery, portal vein, and bile duct are ligated and divided), the infrahepatic vena cava is dissected. Venovenous bypass is not necessary because a centralized DSRS can sufficiently decompress the portal system into the vena cava. If the bowel becomes congested after the portal vein has been clamped, the surgeon should avoid this method because the congestion suggests either insufficient flow through the DSRS or inadequate communication between the portomesenteric system and the DSRS.

The anterior surface of the infrahepatic vena cava is surgically explored and dissected to expose the origin of the left renal vein. The duodenum may be mobilized with the Kocher maneuver. The surgeon should minimize this dissection to avoid bleeding from the collateral vessels behind the pancreas. After the left renal vein is exposed and encircled, the retrohepatic dissection is performed. The short hepatic veins are ligated and divided, and the liver is removed using the piggyback technique.9

The left renal vein is then clamped and divided very near the vena cava. To facilitate portal vein anastomosis during the warm ischemia time, a donor iliac vein graft is anastomosed to the distal renal vein as an interpositional graft. When the left renal vein is clamped, the bowel becomes congested, suggesting that this is the primary route for mesenteric venous return. After the suprahepatic caval anastomosis is performed using the piggyback technique, the donor portal vein is anastomosed to the interpositional graft (Figure).

We performed simultaneous arterial and portal reperfusion in the first patient to secure blood flow to the liver in the event that portal vein flow was inadequate. With the experience gained from the first patient, we performed the arterial reconstruction after reperfusion in the remaining 4 patients.

Table 1. Patient Summary*

<table>
<thead>
<tr>
<th>Patient No./ Age, y/Sex</th>
<th>Diagnosis</th>
<th>DSRS to OLT</th>
<th>Portal Flow by Doppler Before OLT</th>
<th>Portal Vein by Intraoperative Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/44/F</td>
<td>HCV</td>
<td>5 y</td>
<td>HFF, extremely small</td>
<td>Phlebosclerotic, very small</td>
</tr>
<tr>
<td>2/54/F</td>
<td>Cryptogenic</td>
<td>14 mo</td>
<td>PVT</td>
<td>PVT</td>
</tr>
<tr>
<td>3/51/M</td>
<td>HCV</td>
<td>11 mo</td>
<td>HFF</td>
<td>HFF</td>
</tr>
<tr>
<td>4/50/M</td>
<td>HCV</td>
<td>7 y</td>
<td>HFF</td>
<td>PVT</td>
</tr>
<tr>
<td>5/66/F</td>
<td>PSC</td>
<td>5 y</td>
<td>HFF</td>
<td>HFF</td>
</tr>
</tbody>
</table>

*DSRS indicates distal splenorenal shunt; OLT, orthotopic liver transplantation; HCV, hepatitis virus C infection; HFF, hepatopetal flow; PVT, portal vein thrombosis; HFF, hepatofugal flow; PSC, primary sclerosing cholangitis.

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demonstrated normal velocity (40-100 cm/s) in the portal veins of all patients. Mean operative time was 10 hours 43 minutes. Mean blood transfusion amount was 9.8 units. Of the 5 patients, 3 had uneventful hospital courses with the length of stay ranging from 9 to 13 days after OLT. One patient developed wound dehiscence resulting in a prolonged hospital stay, and another died of multiple complications (Table 2). One patient developed renal insufficiency during the early postoperative period, manifested by a transient increase in creatinine concentration. This was attributed to drug toxicity, and was resolved.

At last follow-up (mean time, 17.75 months; range, 6-41 months), 4 patients were alive and well. They had all returned to their normal daily activities and had normal liver function test results, with the exception of 1 patient whose transaminase levels were mildly elevated due to recurrent hepatitis C.

The patient who died developed hepatic artery thrombosis and an associated bile leak from the hepaticojejunostomy. She underwent retransplantation 36 days after her first procedure. The donor portal vein was reconstructed to the same interpositional graft because the Doppler ultrasound and portal angiogram showed normal flow through the portal vein. Postoperative ultrasound again showed normal portal flow. Her second postoperative course was complicated by a ruptured pseudoaneurysm at the hepatic artery anastomosis secondary to intraperitoneal infection. The patient died of sepsis 92 days after her first OLT. An autopsy revealed the patency of both the DSRS and the left renal vein to portal vein anastomosis.

**COMMENT**

Since Warren et al\(^\text{10}\) first described the DSRS in 1967, this selective shunt procedure has been widely performed for refractory variceal bleeding. The current indication for this shunt procedure is variceal bleeding resistant to endoscopic therapy with relatively well-preserved liver function.\(^\text{1-3}\) This shunt procedure was designed to decompress the gastrosplenic venous system selectively, while maintaining adequate portal perfusion and preserving hepatopetal flow in the portomesenteric system.\(^\text{10}\) As a result, this shunt procedure prevents life-threatening variceal bleeding, and by maintaining adequate portomesenteric flow, it offers a low risk of developing hepatic encephalopathy or hepatic decompensation. Nevertheless, with time, the shunt loses its selectivity with the progressive formation of collateral vessels from the portomesenteric system to the gastrosplenic system.\(^\text{11}\) This formation of collateral vessels decreases the portal perfusion pressure, and hepatopetal flow in the portomesenteric system will subsequently be lost through centralization of the shunt.\(^\text{11}\)

One of the initial concerns in performing OLT in patients with patent DSRSs was identifying a method for securing the portal venous flow; if left intact, the patent shunt could decrease portal flow. Esquivel et al\(^,\text{6}\) reported the first successful series of liver transplantation in patients with patent DSRSs. To restore the flow to the portal vein, the authors performed a splenectomy after hepatic replacement. They also divided or ligated the shunt in most of their patients.\(^\text{6}\) In contrast, a later report suggested that disconnection of the shunt was unnecessary.\(^\text{12}\) Nonetheless, the series included only 2 patients who had already received a DSRS. In another series, Langnas et al\(^,\text{7}\) describe a patient with a postransplantation portal vein thrombosis attributed to the portal flow by a patent DSRS. Peripancreatic collateral vessels draining into the patent DSRS were siphoning flow from the portal vein, even though a splenectomy had been performed at the time of OLT. Therefore, when collateral vessel formation is significant, the authors recommend a splenectomy in addition to either the ligation of peripancreatic collateral vessels or the direct ligation of the shunt.\(^\text{8}\)

In our experience, the DSRS is already centralized in many patients who develop liver failure who are referred for OLT; they frequently have hepatofugal flow in the portal vein and, at times, a portal vein thrombosis. Restoring the portal flow by dismantling the shunt is mandatory because these patients may develop postransplantation portal vein thrombosis or graft atrophy owing to a stealing phenomenon if the shunt is left untouched. However, dismantling the shunt markedly increases the complexity of the procedure and a splenectomy may have a detrimental effect in host defense.

Among the patients in our series, the method we described is simple, does not require splenectomy, provides adequate blood flow to the portal vein, and does not require venous jump graft in patients with portal vein thrombosis. Some may assume that this method may not provide sufficient decompression of the portomesenteric venous system. However, if the bowel is sufficiently decompressed after ligation of the native portal vein and before division of the left renal vein, the entire mesenteric system should remain decompressed after the hepatic implantation.

In a personal communication, Henri Bismuth, MD, of Paul Brousse Hospital, Villejuif, France (December

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**Table 2. Intraoperative and Postoperative Summary**

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>OR Time*</th>
<th>Blood Transfusion, U</th>
<th>Complications</th>
<th>Length of Hospital Stay, d</th>
<th>Status</th>
<th>Time to Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 h 5 min</td>
<td>8</td>
<td>None</td>
<td>9</td>
<td>Alive</td>
<td>41 mo</td>
</tr>
<tr>
<td>2</td>
<td>12 h 35 min</td>
<td>15</td>
<td>Hepatic artery thrombosis, bile leak</td>
<td>92</td>
<td>Dead</td>
<td>92 d</td>
</tr>
<tr>
<td>3</td>
<td>11 h 26 min</td>
<td>10</td>
<td>None</td>
<td>9</td>
<td>Alive</td>
<td>16 mo</td>
</tr>
<tr>
<td>4</td>
<td>10 h 33 min</td>
<td>10</td>
<td>Wound infection, recurrent hepatitis C</td>
<td>13</td>
<td>Alive</td>
<td>8 mo</td>
</tr>
<tr>
<td>5</td>
<td>10 h 58 min</td>
<td>6</td>
<td>Wound dehiscence</td>
<td>32</td>
<td>Alive</td>
<td>6 mo</td>
</tr>
</tbody>
</table>

* OR indicates operating room.
involved, they did not discontinue the use of the shunt. Shunts can lose selectivity due to collateral vessels stealing flow from the portal vein. However, in the presence of portal vein thrombosis or insufficient native portal vein (ie, small and phlebosclerotic portal vein), our method is preferable because portal inflow reconstruction does not require construction of a mesenteric venous jump graft or extensive dissection of the portal vein.

In a case reported by Sheil et al, liver transplantation with left renal vein to portal vein reconstruction addressed the situation of portal vein thrombosis after an unusual central shunt procedure. Whereas the patients in our study had distal splenorenal shunts, the patient in the case report by Sheil and colleagues had a proximal left renal vein-to-side splenic vein shunt (renal-lieno shunt). A renoporal anastomosis was also performed, but for a different purpose.

We believe that our method is ideal for patients whose shunts have lost selectivity due to collaterals stealing flow from the portal vein. In these patients, the portomesenteric system drains into the DSRS through collateral vessels, and thereby permits adequate decompression of the bowel. Alternatively, if the DSRS is relatively new and the selectivity of the shunt has been maintained, conventional portal vein reconstruction without dismantling the shunt should be the procedure of choice.

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