

Liver Transplantation With Renoportal Anastomosis After Distal Splenorenal Shunt

Tomoaki Kato, MD; David M. Levi, MD; Wirviston DeFaria, MD; Seigo Nishida, MD; Andreas G. Tzakis, MD

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 reperused 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.

Arch Surg. 2000;135:1401-1404

ALTHOUGH endoscopic therapy and the transjugular intrahepatic portosystemic shunt have superseded the role of surgery in the management of portal hypertension, surgical shunt procedures are still a desirable option for selected patients.^{1,2} Compared with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.³⁻⁵ 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 peri-

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.⁶⁻⁸ 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.

From the Division of Transplantation, University of Miami School of Medicine, Miami, Fla.

METHODS

Data were retrospectively collected on 5 patients with prior DSRS 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.

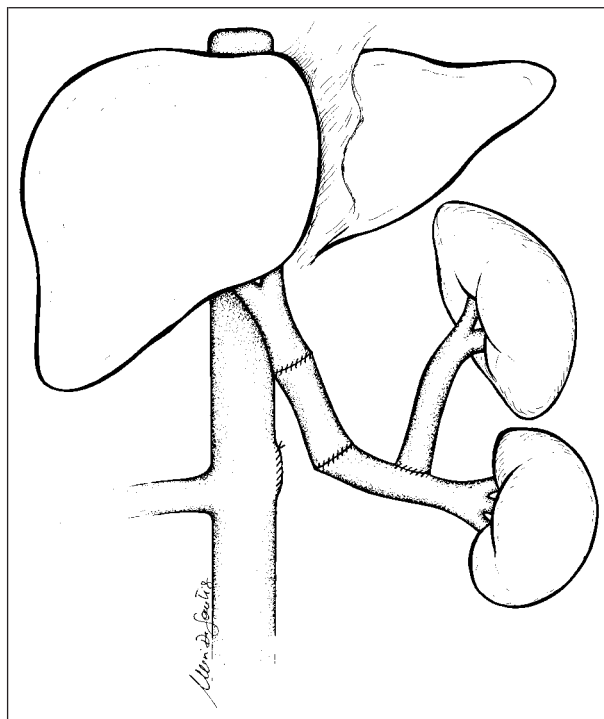
The anterior surface of the infrahepatic vena cava is surgically explored and dissected to expose the origin of the left renal vein. The duodenum may be mobilized with the Kocher maneuver. The surgeon should minimize this dissection to avoid bleeding from the collateral vessels behind the pancreas. After 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.

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-



Portal vein anastomosis. The donor portal vein is anastomosed to the left renal vein with an interpositional iliac vein graft. The mesenteric flow drains into the donor portal vein through the patent distal splenorenal shunt.

Table 1. Patient Summary*

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

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

ency 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 an extremely small portal vein with 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 reperused promptly in all patients. Intraoperative and postoperative Doppler ultrasounds

Table 2. Intraoperative and Postoperative Summary

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

*OR indicates operating room.

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 al¹⁰ 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.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.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.¹¹ This for-

mation of collateral vessels decreases the portal perfusion pressure, and hepatopetal flow in the portomesenteric system will subsequently be lost through centralization of the shunt.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 al⁶ 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.⁶ In contrast, a later report suggested that disconnection of the shunt was unnecessary.¹² Nonetheless, the series included only 2 patients who had already received a DSRS. In another series, Langnas et al⁷ describe a patient with a posttransplantation 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.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 posttransplantation 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

1997), proposed ligation of the proximal left renal vein as an alternative to direct ligation of the shunt. Bismuth's technique features a conventional end-to-end portal vein anastomosis and ligation of the left renal vein close to the inferior vena cava. This approach is a reasonable option because it is simple and secures adequate flow to 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,¹³ 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-ieno shunt). A renoportal 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.

The authors thank Susan E. Siefert, ELS, CBC, who served as the authors' editor, for her assistance in preparation of the manuscript.

Corresponding author: Tomoaki Kato, MD, Highland Professional Bldg, 5th Floor, 1801 NW Ninth Ave, Miami, FL 33136 (e-mail: tkato@med.miami.edu).

REFERENCES

1. Rikkers LF. The changing spectrum of treatment for variceal bleeding. *Ann Surg.* 1998;228:536-546.
2. Jenkins RL, Gedaly R, Pomposelli JJ, Pomfret EA, Gordon F, Lewis WD. Distal splenorenal shunt: role, indications, and utility in the era of liver transplantation. *Arch Surg.* 1999;134:416-420.
3. Henderson JM. Role of distal splenorenal shunt for long-term management of variceal bleeding. *World J Surg.* 1994;18:205-210.
4. Rikkers LF, Jin G. Variceal hemorrhage: surgical therapy. *Gastroenterol Clin North Am.* 1993;22:821-842.
5. Rikkers LF, Sorrel WT, Jin G. Which portosystemic shunt is best? *Gastroenterol Clin North Am.* 1992;21:179-196.
6. Esquivel CO, Klintmalm G, Iwatsuki S, et al. Liver transplantation in patients with patent splenorenal shunts. *Surgery.* 1987;101:430-432.
7. Lagnans AN, Marujo WC, Stratta RJ, et al. Influence of a prior porta-systemic shunt on outcome after liver transplantation. *Am J Gastroenterol.* 1992;87:714-718.
8. Mazzaferro V, Todo S, Tzakis AG, Stieber AC, Makowka L, Starzl TE. Liver transplantation in patients with previous portosystemic shunt. *Am J Surg.* 1990;160:111-116.
9. Tzakis AG, Todo S, Starzl TE. Orthotopic liver transplantation with preservation of the inferior vena cava. *Ann Surg.* 1989;210:649-652.
10. Warren WD, Zeppa R, Fomon JJ. Selective trans-splenic decompression of gastroesophageal varices by distal splenorenal shunt. *Ann Surg.* 1967;166:437-455.
11. Maillard JN, Flamant YM, Hay JM, Chandler JG. Selectivity of the distal splenorenal shunt. *Surgery.* 1979;86:663-671.
12. Brems JJ, Hiatt JR, Klein AS, et al. Effect of a prior portosystemic shunt on subsequent liver transplantation. *Ann Surg.* 1989;209:51-56.
13. Sheil AGR, Stephen MS, Chui AKK, Ling J, Bookallil MJ. A liver transplantation technique in a patient with a thrombosed portal vein and a functioning renal-ieno shunt. *Clin Transplant.* 1997;11:71-73.

Invited Critique

This article presents a novel approach to portal revascularization for liver transplantation after DSRS. The authors have identified 5 patients who developed significant collateral vessels from their high-pressure mesenteric venous circulation across to the low-pressure splenic vein, the shunt, to the left renal vein. In these patients, the progression of cirrhosis with increased obstruction to portal flow led to the total reversal of portal flow and to the mesenteric flow being siphoned to the shunt. The authors appropriately recognized this technique as an alternative means of revascularization of the liver transplant. The choice for patients such as these is either to dissect down to the superior mesenteric vein and place a jump graft to revascularize the new liver, or to use the technique described. In the latter situation, dissection of the superior mesenteric vein can be difficult because of significant large collateral vessels from this vein into the pancreas and along the mesocolon toward the low-pressure DSRS. The alternative is to ignore the superior mesenteric vein dissection and simply isolate the final common outflow of all these collateral vessels (ie, the left renal vein).

Can the decision regarding which technique to follow be better determined preoperatively for patients with prior DSRS? A case can be made for mesenteric arteriography prior to transplantation for all such patients. Wedged hepatic vein injection of contrast and superior mesenteric arteriography with venous phase study will show the portal vein status and the pattern of collateral vessels across to the DSRS and left renal vein. Knowledge of this status before transplantation should reliably predict which approach to take: (1) if the portal vein is patent with prograde flow and no collateral vessels, a routine portal revascularization can be done, and the DSRS left undisturbed; (2) if the portal vein is patent with reversal of flow or large siphoning collateral vessels to the DSRS, a portal vein to portal vein anastomosis can be made; however, a splenectomy and ligation of the shunt at the left renal vein must also be performed; or (3) if the portal vein is thrombosed or too small to use, the surgeon must choose between the 2 options of a superior mesenteric jump graft (with splenectomy and shunt ligation) or the technique described in this article.

Are there any disadvantages to this alternative revascularization procedure? Probably not, in that all the mesenteric flow is passing through this rather circuitous route to the new liver. It does preserve the spleen and avoids what can be a very difficult dissection for splenectomy and ligation of a splenorenal shunt. The authors are to be commended for their development of this concept and its application in 5 patients, showing that it can be successfully performed.

J. Michael Henderson, MD
Cleveland, Ohio