Liver transplantation with cavoportal or renoportal anastomosis
A solution in cases of diffuse portal thrombosis

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SUMMARY

Objective — Liver transplantation was contraindicated in patients with diffuse thrombosis of the portal vein until the recent use of graft portal vein reperfusion with the caval flow or one of its tributaries. Long term results of these procedures are reported here.

Patients and methods — Eight patients with diffuse portal vein thrombosis were transplanted by portal reperfusion via latero-terminal anastomosis between the native caval vein and the graft portal vein (2 patients) or termino-terminal between the native left renal vein and the graft portal vein (6 patients).

Results — Three patients died 3, 3 and 6 months following transplantation from intracerebral hemorrhage, cardiac arrest, and chronic rejection respectively. Three patients had complicated portal hypertension. Five patients were alive at home with a median follow-up of 9 months (2 to 37 months) with normal liver and kinase functions.

Conclusion — Portal reperfusion with the caval vein flow allows transplantation of patients with diffuse portal vein thrombosis. According to our experience and to the analysis of the literature, reno-portal anastomosis is preferable to cavo-portal reconstruction.

Until recently diffuse portal vein thrombosis was a formal technical contraindication for liver transplantation because of the requirement for portal inflow, at least initially [1, 2]. Salvage solutions have been proposed: combined liver-small bowel transplantation and arterIALIZATION of the graft’s portal vein, either permanently [3] or temporarily [4]. None of these methods have been widely developed. Portacaval hemitransposition where the native inferior vena cava is anastomosed to the graft portal vein using a termino-terminal anastomosis or a terminalized latero-terminal anastomosis with ligature of the retrohepatic vena cava has been proposed by Tzakis et al. [5]. There have been rare reports of hemitransposition [5-11] but the details of long-term outcome remain unknown.

We describe here two technical variants of portal reperfusion from the vena cava in patients with diffuse thrombosis of the portal vein where retrohepatic flow is preserved [11] and report our mid-term results.

Patients and methods

Portal reperfusion from caval flow was used between November 1996 and May 2001 in 8 liver transplant recipients who had diffuse thrombosis of the portal system. Indications for transplantation, and the patients clinical and hepatic status are summarized in table I. Diffuse thrombosis of the portal system had led to spleno-renal collaterals, spontaneous in one patient as visualized on celiomesenteric arteriography, and at surgery in two. Another patient had had a derivation between a branch of the superior mesenteric vein and the vena cava. The surgical technique for renoportal hemitransposition has been described in detail [11] and is summarized schematically in figure 1. When the patients had a splenorenal anastomosis (spontaneous in one and surgical in two), portal perfusion of the graft was re-established via a renoportal anastomosis (three patients). In one other patient with a mesocaval anastomosis, portal inflow was re-established via a latero-terminal cavoportal anastomosis. These procedures were performed in these four patients because of the possibility of re-establishing at least partial portal flow through the graft via spontaneous or surgical portosystemic anastomosis. For the other four patients who had no detectable portosystemic flow on pre- or peroperative celiomesenteric arteriography, we decided to use a renoportal anastomosis (3 patients) after failure of one attempt to achieve a latero-terminal caval portal anastomosis (1 patient). We chose the renoportal anastomosis because of the better co-axiality and congruency and better match between left renal vein flow and portal vein flow. In cirrhotic patients, flow rate in the portal vein ranges from 0.6-0.8 L/minute [12], similar to renal vein flow estimated at 0.6 L/minute [13], while the flow rate in the suprarenal and subhepatic inferior vena cava is approximately 2 L/min [13]. Finally the renoportal anastomosis preserved the physiological retrohepatic inferior vena cava that has lost only left renal venous flow. For the two patients with a latero-terminal cavoportal anastomosis, the retrohepatic inferior vena cava was calibrated with a tight caval clip under duplex Doppler guidance just after apparition of the portal inflow, maintaining retrohepatic caval flow. The native retrohepatic inferior vena cava was resected in all 8 patients.
Kidney morphology was normal with moderate histological chronic arterial and biliary rejection and normal hepatocytes. Autopsy, all the anastomoses were patent. Pathology reported esophageal varices that were controlled by sclerotherapy. At and experienced 4 episodes of digestive bleeding due to ruptured While waiting for retransplantation, this patient developed ascitis Liver function had remained normal until terminal liver failure. Chronic graft rejection while on the retransplantation waiting list. Table II). Three patients died 3 months, 3 months and 6 months after transplantation (table II). − Main characteristics of 8 patients transplanted with cavo-portal hemitransposition (2 patients) or reno-portal anastomosis (6 patients).

<table>
<thead>
<tr>
<th>Patient No*</th>
<th>Sex/Age</th>
<th>Diagnosis</th>
<th>Pre-transplantation porto-systemic shunt</th>
<th>Significant complications before transplantation</th>
<th>Clinical status at time of transplantation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>M, 48</td>
<td>Cirrhosis of unknown origin</td>
<td>None</td>
<td>Rupture of esophageal varices, ascitis, chronic encephalopathy</td>
<td>Hospitalized, Child C</td>
</tr>
<tr>
<td>2*</td>
<td>M, 45</td>
<td>Hemochromatosis</td>
<td>Spontaneous splenorenal</td>
<td>Chronic encephalopathy</td>
<td>Living at home, Child C</td>
</tr>
<tr>
<td>3</td>
<td>F, 40</td>
<td>Retransplantation for diffuse angiocolitis</td>
<td>Surgical splenorenal</td>
<td>None</td>
<td>Living at home, Child C</td>
</tr>
<tr>
<td>4</td>
<td>M, 50</td>
<td>Hepatitis B cirrhosis</td>
<td>Surgical splenorenal</td>
<td>Chronic encephalopathy</td>
<td>Living at home, Child C</td>
</tr>
<tr>
<td>5</td>
<td>M, 47</td>
<td>Cirrhosis of unknown origin</td>
<td>Surgical mesocaval</td>
<td>Chronic encephalopathy</td>
<td>Living at home, Child C</td>
</tr>
<tr>
<td>6</td>
<td>M, 56</td>
<td>Alcoholic cirrhosis</td>
<td>None</td>
<td>Rupture of esophageal varices, ascitis, chronic encephalopathy</td>
<td>Hospitalized, Child C</td>
</tr>
<tr>
<td>7</td>
<td>M, 29</td>
<td>Cirrhosis of unknown origin</td>
<td>None</td>
<td>Hepatopulmonary syndrome</td>
<td>Living at home, Child B</td>
</tr>
<tr>
<td>8</td>
<td>F, 38</td>
<td>Acute Budd-Chiari</td>
<td>None</td>
<td>Rupture of esophageal varices, ascitis, encephalopathy</td>
<td>In ICU, intubed, Child C</td>
</tr>
</tbody>
</table>


Postoperative care and follow-up

The same postoperative protocol used for transplant recipients without portal thrombosis, previously described in detail [14], was used for these patients. Briefly, immunosuppression was initiated with tacrolimus and somedrol. A continuous intravenous perfusion of heparin was started immediately in the recovery room, achieving an activated partial thromboplastin time (APTT) to 1.5 to 2 N, and pursued for the entire period of intensive care then replaced by low-molecular-weight heparin during the rest of the hospital stay, as for all our transplant recipients. Duplex-Doppler exams were performed daily in the intensive care unit and twice weekly during the remainder of the hospital stay, then at each follow-up visit.

At discharge, patients were given an anti-platelet agent in addition to the usual treatment for transplant recipients.

Results

Portal reperfusion using caval flow was achieved without technical difficulty and without using a venous graft in all 8 cases. Duration of cold ischemia was 6 to 11 hours 39 minutes (median, 7 hours 33 minutes). Perioperative transfusions required 0 to 17 packed red cell units (median, 5 units). Five of the 8 patients are alive at median of 9 months follow-up (range, 2-37 months). Three patients died 3 months, 3 months and 6 months after transplantation (table II).

Cause of death (table II)

Patient no 1 died 6 months after transplantation due to chronic graft rejection while on the retransplantation waiting list. Liver function had remained normal until terminal liver failure. While waiting for retransplantation, this patient developed ascitis and experienced 4 episodes of digestive bleeding due to ruptured esophageal varices that were controlled by sclerotherapy. At autopsy, all the anastomoses were patent. Pathology reported chronic arterial and biliary rejection and normal hepatocytes. Kidney morphology was normal with moderate histological fibrosis.

Patient no 5 died 4 months after transplantation on the day of discharge due to rupture of a cerebral vascular malformation. Liver function was normal at the time of death. Autopsy did not show evidence of any technical complication and liver and renal histologies were unremarkable.

Patient no 6 died at home 3 months after transplantation due to unexplained cardiorespiratory arrest. A few days before death, this patient had normal liver function with persistent ascitis that did not require drainage. Esophagogastric endoscopy was normal. Autopsy was not possible.

Morbidity (table II)

Two patients (no 1 and 8) experienced two episodes of esophagogastric variceal bleeding that were controlled by sclerotherapy or ligature. These two patients did not have a spontaneous or surgical portosystemic shunt prior to transplantation.

Three patients (no 1, 6, 8) developed transient ascitis postoperatively which resolved in all three between 1 to 4 months later. In patient no 1, ascites recurred together with bleeding due to ruptured esophageal varices when chronic rejection developed. Other severe complications included one lymphoproliferative syndrome which regressed on lowering the dose of immunosuppressive therapy (patient no 2), and one ileal perforation (patient no 4). Currently, the 5 surviving patients are in excellent condition and have been living at home 2 to 37 months after transplantation. These patients are following the same follow-up protocol as our other transplant recipients.

Liver and renal function

Production of abundant dark bile was noted after reperfusion of the 8 grafts. Table III summarizes the time course of liver and renal function tests after transplantation. Test results had reached levels comparable with those observed in the general liver transplantation population 30 days after transplantation [14, 15].

Portal and caval flow

Portal inflow and inferior vena cava flow were normal at all duplex Doppler exams.

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* D. Azoulay et al.

**Table I.** – Main characteristics of 8 patients transplanted with cavo-portal hemitransposition (2 patients) or reno-portal anastomosis (6 patients).
Fig. 1 – Technical alternatives of portal reperfusion with caval inflow.

(n) number of cases performed in the present series. The other technical alternatives were reported by Tzakis et al. [5].

a) End to end cavo-portal anastomosis;
b) latero-terminal anastomosis between native vena cava and graft portal vein with retro-hepatic vena cava constriction;
c) latero-terminal anastomosis between native vena cava and graft portal vein preserving the retrohepatic caval flow by calibration (by a clip) of the retrohepatic caval vein (2 cases);
d) termino-terminal anastomosis between native left renal vein and graft portal vein (6 cases).

Table II. – Main intra- and post-operative characteristics (8 patients).

<table>
<thead>
<tr>
<th>Patient No</th>
<th>Cold ischemia Minutes</th>
<th>Intraoperative transfusion (red cell units)</th>
<th>Post-operative complications**</th>
<th>Hospitalization ICU/total (days)</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>456</td>
<td>14</td>
<td>Rupture of esophageal varices, transient ascites</td>
<td>18/89</td>
<td>Death at 7 months, chronic rejection while waiting for retransplantation</td>
</tr>
<tr>
<td>2*</td>
<td>420</td>
<td>0</td>
<td>None</td>
<td>8/30</td>
<td>Living at home, 37 months</td>
</tr>
<tr>
<td>3</td>
<td>475</td>
<td>13</td>
<td>None</td>
<td>6/36</td>
<td>Living at home, 22 months</td>
</tr>
<tr>
<td>4</td>
<td>699</td>
<td>3</td>
<td>None</td>
<td>69/111</td>
<td>Death at 4 months before discharge, cerebral hemorrhage</td>
</tr>
<tr>
<td>5</td>
<td>450</td>
<td>5</td>
<td>None</td>
<td>10/36</td>
<td>Living at home 9 months</td>
</tr>
<tr>
<td>6</td>
<td>360</td>
<td>5</td>
<td>Transient ascites</td>
<td>14/36</td>
<td>Death at 3 months while living at home, cardiac arrest</td>
</tr>
<tr>
<td>7</td>
<td>442</td>
<td>0</td>
<td>None</td>
<td>54/59</td>
<td>Living at home, 7 months</td>
</tr>
<tr>
<td>8</td>
<td>485</td>
<td>17</td>
<td>Ascites, ruptured gastric varice</td>
<td>23/54</td>
<td>Living at home, 2 months</td>
</tr>
</tbody>
</table>

* Reported earlier [11], patients 1 and 5 had a latero-terminal cavoportal anastomosis preserving retrohepatic caval flow; the other patients had a termino-terminal reno-portal anastomosis.
Histology

We obtained 13 liver biopsies in 7 patients, 8 days to 2 years after transplantation (median, 42 days). Eight biopsies were obtained within 3 months of transplantation and 5 were obtained at 4 (two patients), 11, 12, and 24 months. Transjugular puncture was used for 6 biopsies allowing measurement of the portosuprahepatic gradient. None of these biopsies demonstrated histological lesions related to surgery.

The portosuprahepatic gradient was normal, less than 5 mm Hg in the 5 patients with normal histology. In one patient with severe acute rejection, the gradient was high (11 mm Hg) then normalized after successful treatment of rejection.

Discussion

Portal reperfusion of the liver graft using caval flow enabled us to transplant 8 patients with a “normal” contraindication for transplantation. None of the three deaths were related to the surgical technique used. Liver function, portal hemodynamics, and liver histology were normal after recovery.

Excluding two cases previously reported by our center [11] and including the present series, there have been 32 reported cases of liver transplantation using portal reperfusion with caval flow in 31 patients with diffuse thrombosis of the portal vein [5-10]. These cases are summarized in Table IV. The liver transplantation procedure used in these 32 cases is technically feasible. Among these patients with diffuse thrombosis of the portal system without spontaneous or surgical shunt, transient

Tableau IV. − Cavo-portal hemitransposition or reno-portal anastomosis in liver transplantation: review of the literature.

<table>
<thead>
<tr>
<th>1st author (ref)</th>
<th>Patients n°</th>
<th>Portal reconstruction</th>
<th>Post-operative complications a</th>
<th>Post-transplantation course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tzakis [5]</td>
<td>9</td>
<td>Cavoportal T-T n = 5</td>
<td>Ruptured varices n = 5, Transient ascitis n = 5</td>
<td>Deaths n = 4: — D2, not specified; — D28, sepsis; — 10 months, sepsis; — D26, pulmonary embolism Living n = 5: 6-11 months.</td>
</tr>
<tr>
<td>Pinna [6]</td>
<td>11</td>
<td>Cavoportal T-T n = 6</td>
<td>Ruptured varices n = 2, Transient ascitis n = 11, Deep vein thrombosis n = 3, Portal thrombosis n = 3</td>
<td>Deaths n = 4: — D28, sepsis; — 10 months, sepsis; D26: pulmonary embolism; — DX: heart failure Living n = 7, mean = 1 year</td>
</tr>
<tr>
<td>Olausson [7]</td>
<td>6 d</td>
<td>Cavoportal T-T n = 7</td>
<td>Ruptured varices n = 1, Transient ascitis n = 1, Portal thrombosis n = 2</td>
<td>Death n = 1: — DB: sepsis Living n = 5: delay not given</td>
</tr>
<tr>
<td>Santaniello [9]</td>
<td>1</td>
<td>Cavoportal L-T + ligature of the retro-hepatic IVC</td>
<td>Hemorrhagic gastritis Transient ascitis</td>
<td>Living at 9 months</td>
</tr>
<tr>
<td>Weeks [10]</td>
<td>1</td>
<td>Cavoportal T-T n = 1</td>
<td>Portal thrombosis Deep vein thrombosis</td>
<td>Living at 20 months</td>
</tr>
<tr>
<td>Azoulay</td>
<td>8</td>
<td>Cavoportal L-T n = 2 + ligature of the retro-hepatic IVC Renoporal T-T n = 6</td>
<td>Ruptured varices n = 2, Transient ascitis n = 13</td>
<td>Deaths n = 3: — 3 months, cerebral hemorrhage — 6 months, chronic rejection — 4 months, cerebral hemorrhage Living n = 5: 2-37 months</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>Cavoportal T-T n = 17 Cavoportal L-T n = 9 + ligature of the retro-hepatic IVC T-T n = 2 + calibration of the retro-hepatic IVC T-T n = 6</td>
<td>Varic rupture or gastritis n = 9, Transient ascitis n = 10, Portal thrombosis n = 3, Deep vein thrombosis n = 4</td>
<td>Deaths n = 8 Living n = 23</td>
</tr>
</tbody>
</table>

a Not including complications related to portal hypertension or specific to portal reconstruction. b Nine patients in four different centers. c Including 5 patients in the series reported by Tzakis et al. [5]. d One patient transplanted twice with cavoportal hemitransposition. L-T latero-terminal anastomosis, T-T termino-terminal anastomosis, IVC: inferior vena cava.
ascites was noted in 20/32 (62.5%) and at least one episode of digestive bleeding in 9/32 (28%) [5-9] (table IV). This is not surprising since prehepatic portal hypertension persists despite transplantation. In other words, liver transplantation transforms a condition of diffuse portal thrombosis with liver disease into a condition of diffuse portal thrombosis with a healthy liver. Logically, these transplant recipients should be given preventive treatment to avoid digestive bleeding subsequent to portal hypertension. Tzakis’ team proposes per-transplantation prophylactic treatment of digestive hemorrhage.

None of the 5 patients who underwent splenectomy and gastric devascularization during the transplantation operation subsequently developed postoperative episodes of digestive bleeding [6].

Six cases of portal thrombosis have occurred in 24 patients (25%) with termino-terminal cavoportal anastomoses (n = 17) or terminalized latero-terminal anastomosis with ligation of the retrohepatic vena cava (n = 7) [6-10, 10]. This high incidence of portal thrombosis might be related to slower caval flow entirely directed into the graft. Hepatic resistance might also be aggravated under certain circumstances of acute rejection [16]. The same hypothesis has been put forward to explain four subhepatic deep vein thromboses [6, 10]. The fact that we did not observe such complications may be related to the preserved caval flow obtained with both techniques we used and also perhaps to effective anticoagulation therapy instituted immediately after the end of the operation. None of the 6 patients in the Miami series [6], where patients were given anticoagulant therapy postoperatively, developed a thrombotic complication.

Our experience and that reported by others leads us to propose the following attitude for liver transplantation in patients with diffuse thrombosis of the portal vein: for portal reperfusion in patients with a surgical or spontaneous mesocaval shunt draining directly into the inferior vena cava (hemorrhoid-type shunt), the logical reconstruction is latero-terminal cavoportal anastomosis with calibration of the retrohepatic inferior vena cava to drain at least part of the portal flow into the graft, allowing satisfactory blood flow into the liver yet preserving flow in the retrohepatic inferior vena cava. For the other patients, we prefer a renocaval anastomosis which assures portal perfusion with a flow rate closely matching that in the portal vein and optimal co-axiality and congruence of the anastomosed vessels while preserving retrohepatic flow in the inferior vena cava.

In patients with portal hypertension, it is important to search for esophagogastric varices, to be treated preoperatively by endoscopic sclerotherapy or ligature, then to monitor development of esophagogastric varices postoperatively and provide prophylactic medical or endoscopic treatment for bleeding. Per-operative treatment of varices, by performing splenectomy and esophagogastric devascularization without esophageal transection for example, should be discussed on a case-by-case basis balancing the risk of postoperative digestive bleeding against that of splenectomy in a transplant recipient [17-19].

Conclusion

Portal reperfusion of the liver graft using caval flow enables transplantation in patients with diffuse thrombosis of the portal vein. Liver and renal function, portal hemodynamics, and liver histology are normal at mid-term. If the patient does not have spontaneous or surgical portosystemic shunt preoperatively, portal hypertension should be treated before and after transplantation [5, 6]. Renoporal anastomosis should be used more widely for transplantation in patients with splenorenal anastomosis with a central [20], or laterolateral or distal configuration which has lost its selectivity [21].

REFERENCES


