Technical aspects of liver transplantation
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CHAPTER 5

END-TO-SIDE CAVAL ANASTOMOSIS IN ADULT PIGGYBACK LIVER TRANSPLANTATION

Polak WG, Nemes BA, Miyamoto S, Peeters PMJG, de Jong KP, Porte RJ, Slooff MJH

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ABSTRACT

No consensus exists regarding the optimal reconstruction of the cavo-caval anastomosis in piggyback orthotopic liver transplantation (PBLT). The aim of this study was to analyze our experience with end-to-side (ES) cavo-cavostomy. Outcome parameters were patient and graft survival and surgical complications. During the period 1995–2002 146 full-size PBLT in 137 adult patients were performed with ES cavo-cavostomy without the routine use of temporary portocaval shunt (TPCS). In 12 patients (8%) this technique was used for implantation of second or third grafts. Venovenous bypass was not used in any case and TPCS was performed only in eight patients (6%). One-, three- and five-yr patient and graft survival were 84%, 79% and 75%, and 81%, 74% and 69%, respectively. The median number of intraoperative transfusion of packed red blood cells (RBC) was 2.0 (range 0–33) and 30% of the patients (n = 43) did not require any RBC transfusion. Surgical complications of various types were observed after 49 LT (34%) and none of the complications was specifically related to the technique of ES cavo-cavostomy. Our experience indicates that PB-LT with ES cavo-cavostomy is a safe procedure, can safely be performed without the routine use of a TPCS, has a very low risk of venous outflow obstruction and can also be used effectively during retransplantations.
INTRODUCTION

In conventional orthotopic liver transplantation (LT) the retrohepatic inferior vena cava (IVC) is included in the hepatectomy of the native liver. This technique requires complete cross-clamping of the IVC and the portal vein with all hemodynamic consequences and possible complications reported before. To obviate these sequellas the routine use of the venous-venous bypass (VVB) was proposed. In the late 1980s LT with preservation of the IVC, the so called piggyback technique has been introduced. The piggyback technique was first described in the early years of LT. It was popularized in 1989 by Tzakis et al. The PB technique offers several advantages to the conventional technique such as the avoidance of the VVB and its related complications like hypothermia, hemolytic and thrombembolic complications, avoidance of retrocaval dissection, less phrenic nerve injuries, shortening of warm ischemia time (WIT), and operation time. Also perioperative blood loss is reported to be lower when using the PB technique. Therefore, many centers adopted this PB technique. However, no consensus exists regarding the optimal reconstruction of the venous anastomosis with the recipient IVC.

In the original series by Tzakis et al., the caval anastomosis was performed between the suprahepatic part of donor IVC and the common orifice of all three hepatic veins or the common orifice of two hepatic veins (left and middle or right and middle). This is the so called “classical” piggyback technique. Some authors have modified this caval anastomosis by enlarging the orifices of hepatic veins by an incision in the anterior wall of the recipient IVC. Belghiti et al. developed a technique of caval anastomosis in a side-to-side fashion. In this technique both ends of the donor IVC are closed and an anastomosis is made between two newly created openings: one on the anterior wall of the recipient IVC and one on the posterior wall of the donor IVC. The third type of caval anastomosis is the end-to-side (ES) technique, first described by Cherqui et al. In their original series the caudal end of the donor infrahepatic IVC was closed and the anastomosis was made between the end of the donor suprahepatic IVC and a longitudinal incision on the anterior wall of the recipient IVC. Additionally, a temporary portocaval shunt (TPCS) was used routinely by these authors.

At the University Medical Center Groningen (UMCG) the ES cavo-cavostomy, as described by Cherqui et al., is the preferred technique for the IVC anastomosis. However, a temporary portocaval shunt is not routinely used. The ES cavo-cavostomy is not widely used and only two reports have described the results of this PB technique, both...
in a small number of patients 11,22.
The aim of this report is to describe our experience with ES caval anastomosis without
the routine use of temporary portocaval shunt in adult full-size LT, particularly in terms
of outcome and complications specific to this PB technique.

PATIENTS AND METHODS

From January 1995 till December 2002, a total of 292 full-size LT were performed in
256 adult (>16 years) patients. Patients transplanted with the conventional technique
(n=121) or with the piggyback technique, using an end-to-end (n=16) or side-to-side
caval anastomosis (n=7) were excluded from this analysis. In the remaining 148 LT
performed in 137 patients, the piggyback implantation with an ES caval anastomosis
was used. After exclusion of two patients who died intraoperatively before the caval
anastomosis could be made, the study group consisted of 146 LT performed in 137
patients. Demographic data of the patients at time of the transplantation (primary and
retransplantations) are shown in table 1.

Table 1. Patient demographics at time of the liver transplantations.

<table>
<thead>
<tr>
<th>Recipient’s age (yr)</th>
<th>47 (17-68)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication for LT (%)</td>
<td></td>
</tr>
<tr>
<td>Non-cholestatic liver cirrhosis</td>
<td>71 (48)</td>
</tr>
<tr>
<td>Cholestatic liver cirrhosis</td>
<td>32 (22)</td>
</tr>
<tr>
<td>Acute liver failure</td>
<td>13 (9)</td>
</tr>
<tr>
<td>Metabolic liver disease</td>
<td>11 (7)</td>
</tr>
<tr>
<td>Retransplantation</td>
<td>14 (9)</td>
</tr>
<tr>
<td>Other*</td>
<td>8 (5)</td>
</tr>
<tr>
<td>Child-Pugh class</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>23 (16)</td>
</tr>
<tr>
<td>B</td>
<td>67 (46)</td>
</tr>
<tr>
<td>C</td>
<td>56 (38)</td>
</tr>
<tr>
<td>Previous abdominal operation</td>
<td>55 (38)</td>
</tr>
<tr>
<td>High urgency transplantation</td>
<td>17 (12)</td>
</tr>
</tbody>
</table>

NOTE. Continuous variables are presented as median (range) and categorical variables as number (percentage). *Cystic fibrosis (2), polycystic liver disease (2), Budd-Chiari syndrome (1), non-alcoholic steatohepatitis (1), nodular regenerative hyperplasia (1), congenital liver fibrosis (1)
Twelve (8%) of the 146 LT were second transplantations (five after previous piggyback LT with ES caval anastomosis and seven after previous conventional LT) and two third transplantations (both after previous piggyback ES LT). Seven of 146 cases were combined organ transplantations; five liver-kidney and two liver-lung transplantations. Donors were selected as described earlier by our group. All grafts were obtained from heart-beating hemodynamically stable, brain death, ABO identical or compatible donors with standard donor procurement techniques using UW solution for preservation. As of the year 2000 aprotinin was routinely given intraoperatively in patients without renal dysfunction, to reduce hyperfibrinolytic bleeding. Two types of immunosuppressive schemes were used during these eight years of the study. For patients with autoimmune diseases, like autoimmune hepatitis, primary biliary cirrhosis, and primary sclerosing cholangitis a triple immunosuppressive scheme (cyclosporine A, azathioprine and low dose steroids) was used. All other patients received a double immunosuppressive scheme, consisting of low dose steroids together with either tacrolimus or cyclosporine A. Only biopsy proven rejections were treated with boluses of methylprednisolon on three subsequent days. Steroid resistant rejections were treated either with conversion to tacrolimus for patients on cyclosporine A or with antithymocyte globulin for patients on tacrolimus. Infection prevention was routinely used as described earlier. In order to screen for vascular complications (arterial, portal and venous outflow) Doppler ultrasound was performed at postoperative day 1, 4 and 7, and on demand, as indicated by graft dysfunction. Protocol biopsy was taken at the end of the first postoperative week. In the second week a cholangiogram was performed via the biliary drain to verify for biliary complications. In case of fever, cultures were taken from blood, drains still present and/or from secretions (urine, sputum, bile).

Surgical technique
Recipient hepatectomy was performed with preservation of the IVC in a standard manner as described elsewhere. In summary, the hepatoduodenal ligament was dissected and the common bile duct was ligated and transected, whereas hepatic artery and portal vein were kept intact as long as possible to shorten the anhepatic phase (AHP). After mobilization of the liver, the right hepatic vein was oversewn or closed with a vascular stapler device. On the backtable, the caudal end of the donor IVC was shortened and closed over a silastic tube (for venting) with a purse string suture around it. The suprahepatic IVC was left open and the opening extended by a longitudinal midline incision on the posterior wall (Fig. 1).
Figure 1. Posterior aspect of the donor liver graft. The caudal end of the IVC is ligated and the cranial end is left open, and enlarged by midline incision on the posterior wall of the IVC.

Next the native hepatic artery and portal vein were ligated and transected. The middle and left hepatic vein were oversewn and the liver was removed. TPCS was used only in selected cases to minimize the risk of splanic congestion in patients without portal hypertension or in case of very large caudate lobe that encircled the IVC. After tangential clamping of recipient IVC, occluding approximately a third of its lumen, the anterior wall of the IVC was incised longitudinally and the graft is placed orthotopically and rolled to the right. ES anastomosis between donor and recipient IVC was performed using two running sutures (Fig. 2).

Figure 2. The recipient inferior vena cava (RIVC) is clamped tangentially and the anterior wall of the IVC is incised longitudinally. The graft (G) is placed orthotopically and rolled to the right. The beginning of ES anastomosis between donor IVC (DIVC) and recipient IVC is seen.
End-to-side caval anastomosis in adult piggyback liver transplantation

If a TPCS was used it is taken down and the portal vein was anastomosed end-to-end using a continuous suture with a growth factor. The graft was flushed via the portal vein with approximately 400-500 mL blood. The blood was collected via the venting tube in the IVC which is subsequently removed and the purse string suture tied. Next the clamp on the IVC was opened. The arterial anastomosis was done in an end-to-end fashion, preferably using branch patches on donor as well as recipient side. When necessary, arterial interposition graft was used to either suprarenal or infrarenal aorta. In less than one fourth of the patients (n=32) simultaneous reperfusion via the portal and arterial anastomoses was performed. Biliary reconstruction was done either by a duct to duct reconstruction or a hepaticojejunostomy over a silastic or rubber drain. A feeding jejunostomy catheter was inserted at the end of the operation in the majority of patients. Relevant data about the technique are summarized in Table 2.

Table 2. Technique and operative characteristics in 146 transplantations.

<table>
<thead>
<tr>
<th>Type of transplantation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary transplantation</td>
</tr>
<tr>
<td>Second transplantation</td>
</tr>
<tr>
<td>Third transplantation</td>
</tr>
<tr>
<td>Combined organ transplantation</td>
</tr>
<tr>
<td>Temporary portocaval shunt</td>
</tr>
<tr>
<td>Reperfusion (%)</td>
</tr>
<tr>
<td>Sequential</td>
</tr>
<tr>
<td>Simultaneous</td>
</tr>
<tr>
<td>Biliary reconstruction (%)</td>
</tr>
<tr>
<td>End-to-end choledocholedochostomy</td>
</tr>
<tr>
<td>Roux Y hepaticojejunostomy</td>
</tr>
<tr>
<td>Operation time (min)</td>
</tr>
<tr>
<td>CIT (min)</td>
</tr>
<tr>
<td>WIT (min)</td>
</tr>
<tr>
<td>AHP (min)</td>
</tr>
<tr>
<td>REVT (min)</td>
</tr>
<tr>
<td>RBC use (units)</td>
</tr>
</tbody>
</table>

NOTE. Categorical variables are presented as numbers (percentage) and continuous variables as median (range). OT, operation time (time from incision until closure of the abdomen), CIT, cold ischemia time (time from in situ flushing of the donor organ until the liver is removed from ice for implantation), WIT warm ischemia time (time between the liver is removed from ice until reperfusion via portal vein, hepatic artery or both), AHP anhepatic phase (time from explantation of the native liver until reperfusion of the new graft), REVT, revascularization time (time between removal of the liver from ice and reconstruction of both of the portal vein and the hepatic artery).
Follow up
The overall median follow-up period of the patients was 3.5 years (range 0.0-9.6 yr).
The following variables were studied: patient and graft survival, operative characteristics
(operation time, cold ischemia time (CIT), WIT, AHP and blood transfusion requirements),
postoperative morbidity with special attention to complications related to the caval vein
anastomosis. A technique-related complication was defined as a complication resulting
from the implantation technique, like bleeding from a suture line at the cavo-caval
anastomosis or venous outflow obstruction (VOTO) of the hepatic veins due to torsion,
compression, or thrombosis of the hepatic veins or IVC. The incidence of postoperative
renal failure was assessed by need for renal replacement therapy.

Statistical analysis
Continuous variables are presented as median with range and categorical variables as
number with percentage. The Kaplan-Meier method was used for cumulative patient
and graft survival rates. The log rank test was used to compare these rates between
groups. Categorial variables were analyzed using the Pearson’s Chi-square test or the
Fisher’s exact test. Comparison of medians and means between two groups were
done using the Mann-Whitney U-test and the independent sample t-test, respectively.
Calculations were performed using the SPSS/PC+ Advanced Statistics Package, Version
11.5 (SPSS, Chicago, IL).

RESULTS
The overall 1-year, 3-year and 5-year patient survival rate was 84%, 79% and 75%,
respectively. The overall graft survival rate at the same time points were 81%, 73%
and 69%, respectively. There were no differences in patients and graft survival rates
between patients with primary transplantation and patients with retransplantation or
combined organ transplantation (Table 3).
Table 3. Patient and graft survival according to the transplantation type.

<table>
<thead>
<tr>
<th>Type of LT</th>
<th>1-yr Patient</th>
<th>1-yr Graft</th>
<th>3-yr Patient</th>
<th>3-yr Graft</th>
<th>5-yr Patient</th>
<th>5-yr Graft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary LT (n=125)</td>
<td>84% (105)</td>
<td>81% (101)</td>
<td>79% (79)</td>
<td>74% (73)</td>
<td>75% (29)</td>
<td>69% (24)</td>
</tr>
<tr>
<td>Retransplantation (n=14)</td>
<td>86% (11)</td>
<td>81% (10)</td>
<td>86% (6)</td>
<td>70% (5)</td>
<td>86% (2)</td>
<td>70% (2)</td>
</tr>
<tr>
<td>Combined organ</td>
<td>71% (5)</td>
<td>71% (5)</td>
<td>71% (4)</td>
<td>54% (3)</td>
<td>71% (4)</td>
<td>54% (3)</td>
</tr>
<tr>
<td>transplantation (n=7)</td>
<td>84% (122)</td>
<td>81% (118)</td>
<td>79% (90)</td>
<td>73% (83)</td>
<td>75% (35)</td>
<td>69% (29)</td>
</tr>
</tbody>
</table>

NOTE. () Number of patients at risk. p = ns between all types of liver transplantation.

The operative characteristics are listed in Table 2. Median operation time and median WIT were 555 minutes (range 255-890 minutes) and 50 minutes (range 20-130 minutes), respectively. Median intraoperative use of packed red blood cells (RBC) was 2.0 (range 0-33) and 30% patients did not require any RBC transfusions (41% in primary LT). Median time to extubation was one day and median postoperative stay in the intensive care unit was four days.

Primary non-function occurred in 2 patients (1.4%) and both patients received a second transplant successfully. Postoperative surgical complications developed in 49 cases (34%) and they are summarized in table 4. None of surgical complications could specifically be related to the implantation technique used in this series. There were no differences in the incidence of complications between primary LT and retransplantation.

Table 4. Surgical complications.

<table>
<thead>
<tr>
<th></th>
<th>All LT (n=146)</th>
<th>Primary LT (n=125)</th>
<th>RTx (n=14)</th>
<th>COT (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal bleeding</td>
<td>13 (9)</td>
<td>12 (10)</td>
<td>1 (7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Vascular complications</td>
<td>8 (6)</td>
<td>5 (4)</td>
<td>2 (14)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Hepatic artery thrombosis</td>
<td>6 (4)*</td>
<td>4 (3)</td>
<td>1 (7)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Portal vein thrombosis</td>
<td>4 (3)</td>
<td>3 (2)</td>
<td>1 (7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Venous outflow obstruction</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Biliary complications</td>
<td>33 (23)</td>
<td>25 (20)</td>
<td>4 (29)</td>
<td>4 (57)***</td>
</tr>
<tr>
<td>Anastomotic stricture</td>
<td>14 (10)</td>
<td>11 (9)</td>
<td>2 (14)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Bile leak</td>
<td>12 (8)**</td>
<td>10 (8)</td>
<td>2 (14)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>ITBL</td>
<td>11 (7)</td>
<td>7 (6)</td>
<td>1 (7)</td>
<td>3 (43)****</td>
</tr>
</tbody>
</table>

NOTE. Categorical variables are presented as numbers (percentage). COT – combined organ transplantation
* including four late hepatic artery thrombosis; ** bile leak after bile drain removal excluded; *** p=0.04
Primary LT vs COT; **** p<0.00 Primary LT vs COT
However, biliary complications and especially ischemic-type biliary lesions (ITBL) occurred more often in combined organ transplantation, where median CIT was longer than in primary LT or retransplantation (600 min. vs. 515 min; p = 0.67).

The incidence of renal failure after all LT was 17%; 16% for primary LT and 28% for retransplantation (combined liver-kidney transplantation excluded).

Retransplantation was required in 12 patients (8%) having their primary transplantation in the study period: four patients required early retransplantation (within one month after LT) for primary non-function (2), hepatic artery thrombosis (HAT) (1) and portal vein thrombosis (1). The remaining eight patients were retransplanted in the late posttransplant period for ITBL (5) and HAT (3).

The overall inhospital mortality was 11% (16/137 patients). The causes of death for these patients were: multiorgan failure (7), sepsis (3), intracerebral bleeding (3), ruptured splenic artery aneurysm (1), sudden cardiac arrest (1), and metabolic acidosis (1). During the later follow-up period seventeen (13%) patients died. The causes for late death were recurrence of hepatocellular carcinoma in four patients in patients, hepatitis C recurrence in three patients, coronary heart disease in three patients, sepsis in two patients, and multiorgan failure, cholangiocarcinoma recurrence, pulmonary embolism, pneumocystic infection and brain abscess in each one patient.

**DISCUSSION**

This is the largest reported series of ES cavo-cavostomy in adult piggyback LT without the routine use of TPCS. This study shows that this ES caval vein anastomosis can be performed without venous outflow tract obstruction. Our study also demonstrates that this technique of ES cavo-cavostomy can be used successfully in second and third LT. Furthermore, in this series a temporary portocaval shunt was only needed in a minority of the patients (n=8). This type of ES caval anastomosis is not widely used and only two reports of small series are available, describing their results of this piggyback technique however with the routine use of temporary portocaval shunt 11,22. Cherqui et al. designed this type of caval anastomosis “to avoid potential complications due to the upper caval stump” and no graft congestion or outflow complications were observed in his study 22.

In a previous study of our group in which the conventional LT technique (with VVB) was compared with the PB-ES LT 14. Anhepatic phase, revascularization time and WIT
End-to-side caval anastomosis in adult piggyback liver transplantation

were all significantly shorter in the PB-ES LT. Also RBC use was lower in the piggyback technique in comparison to the conventional technique. The long median operation time in the current study was due to the inclusion of combined transplants and the time needed for the routine introduction of a feeding jejunostomy. Also we have a policy of performing meticulous hemostasis. As a result of this policy the median intraoperative use of RBC units was 2 and 30% of all the patients did not require RBC transfusions at all (41% of all primary LT). Blood loss is one of the most important factors determining postoperative morbidity and mortality in LT 27-29.

Although the piggyback technique has many advantages compared with the conventional one and is feasible in the majority of cases, there are some drawbacks of this technique. Reports about an increased heptatectomy time, potential severe bleeding during dissection of the liver from the IVC, and venous outflow tract obstruction have been published 30-33. Parilla et al. demonstrated a 3.8% complication rate related to the piggyback technique in 1112 LT using an anastomosis between either two (median and left) or three recipient hepatic veins and the donor IVC 30. Within the group of intraoperative complications (2.5%), graft congestion after portal revascularization dominated, due to dislocation or rotation of the graft. Early postoperative complications (within first week) occurred in 11 cases (1%) with acute Budd-Chiari syndrome as the most common early complication (nine cases) requiring seven retransplantations. Only three patients developed late postoperative massive ascites as a result of the elevated pressure in the suprahepatic veins, which was controlled with diuretics in all cases. Another multicenter, retrospective study from France showed 4.1% morbidity related to the piggy-back technique among 1361 liver recipients 31. The most common complications in the early postoperative period were hemorrhagic complications in 39 patients (61%), venous outflow problems or Budd-Chiari syndrome in 24 patients (33%) and hemodynamic complications in four patients (6%). Important to note is, that among three different methods of IVC anastomosis (“classical”, side-to-side and end-to-side caval anastomosis) bleeding complications at the cavo-caval anastomosis and Budd-Chiari syndrome occurred less frequently in end-to-side and side-to-side groups that in the “classical” group. Mortality of these complications was 18%. In a very recent study, Cescon et al. in a large series compared three types of orifices used for caval anastomosis in “classical” piggyback LT. Anastomosis to the cuff of the recipient left and middle hepatic veins, anastomosis to the cuff of left and middle hepatic veins with a >1 cm transversal cavoplasty; and anastomosis to the cuff of three hepatic veins with a >1 cm transversal cavoplasty 32. Venous outflow complications occurred in 20 patients
(4.6%) and they were more often seen in the first type of anastomosis (10.8%), than in the second (1.8%) and the third (3.5%) one. Eight patients required retransplantation for venous outflow complications and three (0.7%) died from causes linked to venous outflow stenosis. Results obtained in this study differ from the results demonstrated by Durcef et al., who analyzed the pressure gradient measurements in two methods of suprahepatic caval anastomosis in “classical” piggyback LT 33. They observed that the anastomosis to the cuff from left and middle hepatic veins was sufficient for a good venous outflow without the necessity of additional cavoplasty.

In case of outflow complications after a piggyback transplantation some authors advocated the use of infrahepatic cavo-caval anastomosis in order to achieve sufficient outflow and save the graft and even avoid retransplantation 34,35. This technique was also described in domino liver transplantation by Tzakis et al. in cases of short suprahepatic caval cuff of the domino liver 36.

In the present study we did not observe any case of VOTO. Among bleeding complications (13/146) none was related to the technique of ES caval anastomosis. The described ES caval anastomosis is simple and provides a wide venous outflow from the liver preventing outflow complications. In the “classical” piggyback technique, in which the suprahepatic end of the donor IVC is anastomosed to the common orifices of two or three hepatic veins, there is a higher risk of venous outflow complications because of two possible situations. In the first one, the liver graft might be rotated around the caval anastomosis resulting in the graft congestion and even Budd-Chiari syndrome. In the second situation, the caval anastomosis might present an “accordian-like” compression, which can lead to above mentioned symptoms. Both situations might develop as result of a too long cuff created from orifices of hepatic veins, which is anastomosed to the cranial end of the donor IVC. Therefore, some centers prefer side-to-side or ES caval anastomosis 8,22,37,38.

Hesse et al. reported in 72 patients transplanted with side-to-side cavo-cavostomy venous outflow complications in 4 patients (5.5%) 39. In more recent study from Belgium, the occurrence of venous outflow complications was 1.8% in patients transplanted with side-to-side technique.37. Using side-to-side technique of caval anastomosis the distance between hepatic veins and the closed suprahepatic part of the donor IVC should be at least 1 cm to prevent graft outflow complications. This however, may create a syphon-like outflow tract. In the ES technique this situation is avoided as the cranial part of the donor IVC is left open and enlarged by midline incision on the dorsal side of the donor IVC, creating a long V-shaped lumen for anastomosis.
Important to note is, that retransplantation after LT with piggyback technique is also feasible with the same technique in a quick and safe manner. In this study six first retransplantations and two second retransplantations were performed after piggyback LT with ES caval anastomosis demonstrating the same patient and graft survival and the incidence of technique-related complications as in primary LT.

As advocated by some authors, a TPCS is needed routinely in PB-LT in order to make hepatectomy easier and to improve the outcome. In our series temporary portocaval shunt was used very selectively (6%), only to prevent the risk of splanchnic congestion in patients without portal hypertension or to facilitate native hepatectomy in cases with a large caudate lobe, encircling the IVC. Our policy is to keep the portal vein open as long as possible to shorten the AHP and therefore to avoid complications related to this phase.

In conclusion, results obtained in this study indicate that piggyback LT with ES caval anastomosis is a simple and safe procedure, allowing a very wide anastomosis and eliminating the risk of venous outflow obstruction. It can be performed without routine use of a temporary portocaval shunt and with minimal intraoperative blood product requirements. Moreover, this technique can be used in first and second retransplantations.

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