Transpl Int (1997) 10: 109–112

ORIGINAL ARTICLE

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Piggy-back versus conventional technique in liver transplantation: report of a randomized trial

Received: 30 May 1996
Received after revision: 7 October 1996
Accepted: 28 October 1996

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Abstract Liver transplantation with preservation of the recipient vena cava (the "piggy-back" technique) has been proposed as an alternative to the traditional method. We performed a randomized study on 39 cirrhotic patients, 20 who underwent the piggy-back technique (group 1) and 19 the traditional method using venovenous bypass (group 2) to evaluate the feasibility and true advantages of the piggy-back technique compared to the traditional method. Two patients were switched to the conventional technique due to the presence of a caudate lobe embracing the vena cava in one patient and a caval lesion in the other. Statistically significant differences between the two groups were only found for the warm ischemia time (48.5 ± 13 min for piggy-back vs 60 ± 12 min for the conventional method) and for renal failure (zero cases in group 1 vs four cases in group 2). We therefore believe that liver transplantation with the piggy-back technique can easily be performed in almost all cases, and that only a few, specific situations, such as a very enlarged caudate lobe, do not justify its routine use.

Key words Liver transplantation, technique · Piggy-back, liver transplantation

Introduction

Liver transplantation with preservation of the recipient vena cava, the so-called piggy-back technique, described for the first time by Tzakis et al. in 1989 [12], has been proposed as an alternative to the conventional method [11] in order to maintain a normal caval flow during the anhepatic stage and to avoid the need for a venous by-pass [3, 10]. Initially proposed for particular indications, such as transplants with reduced-size livers, the piggy-back technique is now being adopted with increasing frequency by transplant teams. The fact that there is no dissection of the retrocaval space prevents hemorrhage during transplant. There is no need for venovenous bypass, and thus the problems associated with its use are also avoided. Finally, the absence of an inferior caval anastomosis reduces the overall time of surgery. Some authors [2, 8] stress the advantages of this technique whether a portocaval anastomosis is used or not.

In order to verify the feasibility and true advantages of this technique over the conventional method, we began a randomized study in January 1995 comparing transplantations performed with the piggy-back technique with those performed with the conventional method and involving the use of venovenous bypass.

Materials and methods

Patients

From January 1995 to April 1996, 72 adult liver transplantations were performed in our center. Thirty-nine of these patients (33 males and 6 females) were included and randomized in our

study; the remaining 33 patients did not satisfy the randomization inclusion criteria. Patients were randomized at the beginning of the operation with envelopes containing randomization codes. The patients' age ranged from 20 to 60 years (mean 48 ± 9 years). Twenty patients were randomized for piggy-back liver transplantation (group 1) and 19 for traditional liver transplantation (group 2). All of the patients considered were Child B and C cirrhotics with portal hypertension (Tables 1, 2). Thirty-three patients with previous major abdominal surgery, acute hepatic failure, renal insufficiency (creatinine > 2.5 mg/dl), or who had undergone retransplantation were excluded from the randomization. In the piggy-back group, a temporary portocaval shunt was never used. All conventional operations were performed using a Griffith venovenous bypass, maintaining a blood flow of 2–2.5 l/min through the biopump. Donors and recipients were matched for size (weight and height) and ABO blood groups. A standard, triple immunosuppressive therapy (cyclosporin-azathioprine-steroids) was used, starting steroids intraoperatively and cyclosporin and azathioprine 12 h postoperatively. For steroid-refractory rejection episodes, monoclonal anti-T-cell antibodies (OKT3) were used.

Surgical technique

The piggy-back technique involves isolation of the hepatic hilum in the traditional way and progressive detachment of the liver from the retrohepatic vena cava. The caudate lobe is detached from the inferior vena cava (IVC) and the retrohepatic accessory veins are ligated and divided, freeing the liver completely from the IVC. The right hepatic vein is clamped, sectioned, and oversewn after closure of the right portal vein to maintain a normal flow to the left liver. This maneuver permits easier preparation of the middle and left hepatic veins and reduces the total time of portal clamping. The left portal vein is then divided, the middle and left hepatic veins are clamped together, and the hepatectomy is completed. The middle and left hepatic veins are joined together by dividing the intervening septa after a vascular clamp has been applied laterally on the anterior part of the IVC without interrupting the caval flow. The orifice size is tailored to match the donor IVC and, consequently, the upper caval anastomosis is completed with interrupted sutures. Caval anastomosis with the graft can be performed at the outlet of the three main suprahepatic veins, appropriately tailored, as in the original technique [12], laterally on the IVC [1], or at the outlet of the sagittal and left suprahepatic veins, as in our technique [4, 7]. The liver is flushed with 1 l of 5% albumin solution during the upper vena cava anastomosis through a catheter inserted in the portal vein. Then, the distal end of the donor IVC is stapled with a vascular stapler (Roticulator 30-V3 Autosuture). The liver is reperfused following portal anastomosis and before arterial anastomosis. This technique was applied in both groups. In group 1, the bypass technician was always present in house, but the Griffith bypass was never prepared in advance.

Hemodynamic data and other parameters

Modifications of different hemodynamic parameters (body temperature, heart rate, central venous pressure, mean arterial pressure, pulmonary pressure, blood gas) were recorded before lateral IVC clamping, at the end of the anhepatic stage, and 30 min after revascularization. Cold and warm ischemia time, blood loss, surgical time, intraoperative and postoperative complications, graft function, renal function, and ICU and hospital stay were evaluated with both techniques.

Table 1 Causes of liver cirrhosis in transplanted patients

Number of patients	Piggy-back 18	Conventional 19	*P* value
Postnecrotic cirrhosis	11	12	NS
Primary biliary cirrhosis	2	3	NS
Postalcoholic cirrhosis	4	–	NS
Hepato carcinoma on cirrhosis	1	3	NS
Wilson's disease	–	1	NS

Table 2 Age, recipient liver weight, and renal function in the randomized patients

Number of patients	Piggy-back 18	Conventional 19	*P* value
Age (years)	47 ± 9.2	51.6 ± 7.7	NS
Recipient liver weight (g)	1230 ± 540	1140 ± 130	NS
Preoperative creatinine (mg/dl)	0.9 ± 0.2	1.0 ± 0.4	NS

Statistics

Differences between the two groups were evaluated with an unpaired, two-tailed *t*-test or by chi-square analysis.

Results

Two patients randomized for the piggy-back technique were switched to the conventional technique due, in one case, to the presence of an enlarged caudate lobe posteriorly embracing the retrohepatic vena cava and, in the other case, to a caval lesion during the isolation in the presence of hypertrophy of the caudate lobe. These two patients were put on bypass when it became clear that the piggy-back technique could not possibly be performed. In these two cases, the blood loss was 2 and 1.8 l, respectively, which did not differ from blood loss in group 2 patients. These patients had no postoperative renal failure or primary dysfunction. There were no intraoperative deaths in either group. The hemodynamic pattern during the anhepatic stage did not show any significant variations in either group of patients. Lateral partial clamping of the IVC did not cause any change in mean arterial pressure, IVC pressure, systemic vascular resistance index, or cardiac index.

With the piggy-back technique, the operating time is reduced (mean time 7 h 42 min ± 1 h 27 min vs 8 h 26 min ± 1 h 25 min for the conventional technique)

Table 3 Comparison of intraoperative and postoperative parameters in the two randomized groups (*RBC* red blood cells, *FFP* fresh frozen plasma, *PGNF* primary graft non-function)

Number of patients	Piggy-back 18	Conventional 19	*P* value
RBC transfusion (ml)	2100 ± 1200	2500 ± 2400	NS
FFP transfusion (ml)	2500 ± 800	2600 ± 1100	NS
Operating time (min)	462 ± 87	506 ± 85	NS
Warm ischemia time (min)	48.5 ± 13	60 ± 12	< 0.05
PGNF	2 (10 %)	2 (10.5 %)	NS
Renal failure	0	4 (30.8 %)	< 0.05

and there is less need for intraoperative transfusions (mean quantity of transfused blood 2113 ± 1264 cc for the piggy-back technique vs 2588 ± 2473 cc for the conventional technique). We observed a trend toward a shorter ICU stay (2.8 ± 2.2 vs 4.2 ± 6.5 days) and a shorter total hospital stay (21.5 ± 8.1 vs 31.1 ± 19.2 days) in the group that underwent the piggy-back technique. Warm ischemia time (48.5 ± 13 min with the piggy-back technique vs 60 ± 12 min with the conventional technique) and renal failure (zero cases with the piggy-back technique vs four with the conventional one) were the only two statistically significant parameters ($P < 0.05$; Table 3). In particular, the four patients in group 2 who developed postoperative renal failure had no associated technical problems (caval stenosis, etc.) leading to renal dysfunction. The renal failure developed immediately in the postoperative period and was not correlated with cyclosporin toxicity. One patient required temporary hemodialysis, and the immunosuppressive regimen was switched from cyclosporin to OKT3 for 15 days. No patients developed vascular complications or postoperative hemorrhage. Four patients had graft nonfunction (PGNF), two in each group. Two patients died while awaiting retransplantation and two underwent retransplantation; one of them died from sepsis after 6 months. There was, however, no difference in the incidence of graft nonfunction or postoperative morbidity and mortality between the groups (Table 3).

Discussion

The piggy-back technique, first described by Tzakis et al. [12], originally considery a terminal laterosuperior caval anastomosis and a venovenous bypass. Numerous variations were subsequently made to the original technique, avoiding the use of the bypass and varying the caval anastomosis techniques to include a terminolateral or latolateral fashion [1]. Some authors have suggested the routine creation of a temporary portocaval anastomosis in patients without spontaneous, efficient portocaval shunts [2].

The piggy-back technique has so many advantages over the traditional technique that it has been proposed as routine practice. First, it does not require retrocaval dissection or dissection of the right suprarenal compartment, thus reducing retroperitoneal blood loss. Second, this technique makes it easy to solve the problem posed by different sizes of recipient and donor vena cava. A third advantage is that normal venous return to the heart is possible during the anhepatic stage, making a venovenous bypass unnecessary and thus avoiding the complications linked to its use, such as air embolism and thromboembolism [6, 13]. Finally, making it possible to preserve the IVC, the piggy-back technique avoids the hemodynamic variations that occur during venovenous bypass and during clamping without bypass.

The piggy-back technique has proved to be valid in our experience. No intraoperative complications linked to hemodynamically significant alterations were observed. Our technique of anastomosis on the stump of the sagittal and left suprahepatic veins with enlargement of the incision on the vena cava made it possible to obtain a sufficiently wide anastomotic opening in all cases. The temporary portocaval anastomosis suggested by some authors [1] was never necessary in our experience, probably due to the fact that all of the patients considered in the study were cirrhotics. In the technique described, the portal vein is clamped only after the complete isolation of the liver, so that total portal clamping time is less than 1 h. The most obvious advantage of this technique is the hemodynamic stability during the anhepatic stage, in addition to the reduction in renal insult. Vascular and biliary complications, retransplants, blood loss, and long-term survival were identical to those of the conventional technique.

Our randomized study demonstrated no statistically significant differences between the two techniques with regard to intraoperative hemodynamics, blood loss, or operation time. We noted a trend towards a reduced ICU and total hospital stay with the piggy-back technique. The only variables that proved to be significant from a statistical point of view were postoperative renal insufficiency and warm ischemia time, as already reported by Jones et al. [5] and Meunier et al. [9]. We did not note any differences with regard to the incidence of postoperative vascular complications, primary graft nonfunction, or the number of retransplants. We therefore believe that the piggy-back technique can easily be used in almost all cases. Specific indications for the piggy-back technique are reduced-size or split livers, transplants with volumetric mismatches, and the presence of a previous portocaval anastomosis. Some particular anatomical situations, such as an enlarged caudate lobe,

may make this technique so difficult that its routine use cannot be justified. However, when the piggy-back technique is used, one must bear in mind that there is yet another advantage it offers: without the need for a veno-venous bypass, the cost of the operation is considerably reduced.

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