

Back Table Procedure for the Modified Piggyback Technique of Liver Transplantation: A Simple Test To Identify Caval Leaks on the Bench

Taner Orug, Nicolas Jarufe, Zahir Soonawalla, Koray Tekin, Darius F Mirza, David Mayer

Objectives: In October 2001, we elected to change from the standard orthotopic liver transplantation procedure to the modified piggyback technique with side-to-side cavo-cavostomy, and to document complications such as caval leaks prospectively. Failure to identify and ligate caval tributaries during bench preparation of liver allografts results in troublesome hemorrhage after reperfusion. After our experience with the first 30 piggybacks, we introduced a simple leak test to resolve this problem.

Materials and Methods: The leak test consists of inflating the inferior vena cava with preservation solution via the infrahepatic inferior vena cava after closure of the suprahepatic inferior vena cava at the end of the bench procedure. Between October 2001 and July 2002, 112 whole liver transplants were performed in 108 adults. Standard orthotopic liver transplantation (group 1) was performed in 25, modified piggyback without leak test (group 2) was performed in 30, and modified piggyback after leak test (group 3) was performed in 57 patients. The incidence of caval leaks before and after introduction of the test was compared using the chi-square test.

Results: Nine patients in group 1 (36%) and 13 in group 2 (43%) required additional sutures to control bleeding from caval branches after reperfusion. In group 3, the leak test identified caval tributaries that required ligation in 20 livers (35%) before implantation; none bled after reperfusion.

Of the 37 cases with negative leak test results, 3 (8%) subsequently bled from missed caval branches. Sensitivity, specificity, and accuracy for the leak test were 100%, 92.1%, and 94.7% respectively.

Conclusions: Nearly all small branches of the inferior vena cava can be successfully identified during the back table procedure by performing a leak test.

Key words: *Inferior vena cava, Bleeding, Venous tributary, Marshalls solution, Bench surgery*

The back table procedure is an important step in orthotopic liver transplantation (OLT) and influences the success of the operation. This procedure is the final stage of liver procurement and is usually performed in the recipient theatre [1]. One important step during the back table procedure is careful dissection and preparation of the donor inferior vena cava (IVC) to identify and ligate its tributaries. The right adrenal vein and 2-4 small phrenic veins are usually present and need to be individually controlled [1,2]. Failure to control these veins, or to identify any iatrogenic injury to the IVC and hepatic veins, will result in troublesome hemorrhage after reperfusion. It will then be necessary to mobilize the liver to identify and suture the bleeding sites. Unnecessary liver mobilization not only increases the risk of ischemia to the new liver, but also strains the vascular anastomotic sites and can result in further bleeding. This may prolong operation time and increase operative blood loss.

To identify these sites of potential bleeding, we have devised a modification of the back table procedure that involves flushing of the IVC to test for any leaks. In this study, we prospectively evaluate the efficacy of this leak test to identify leaks and thereby decrease incidence of bleeding from the IVC after reperfusion.

Liver Transplant Unit, Queen Elizabeth Hospital, University Hospitals Birmingham NHS Trust, Birmingham B15 2TH, United Kingdom

Address reprint requests to: David Mayer, MD, The Liver & Hepatobiliary Unit, Queen Elizabeth Hospital, Edgbaston, Birmingham B15 2TH, United Kingdom
Phone: 00 44 121 6272449 Fax: 00 44 121 6273871 E-mail: david.mayer@uhb.nhs.uk

Experimental and Clinical Transplantation (2004) 2: 246-248

Materials and Methods

The method of liver transplantation at the Queen Elizabeth Hospital, Birmingham, United Kingdom, evolved during 2001-2002 from standard OLT to a modified piggyback technique (MPT) with side-to-side cavocavostomy. The back table procedure for MPT involves an additional step of closure of the upper and lower ends of the IVC. A significant incidence of bleeding points from missed venous tributaries of the IVC was observed, both in the standard and MPT. This led us to devise a test to identify these leaks at the back table.

From October 2001 to August 2002, there were 112 adult whole liver transplant back table procedures: 25 were for standard OLT and 87 were for the MPT. The leak test was performed in 57 of the MPTs and has now been adopted as the procedure of choice. The surgeon performing the liver transplant was blinded to the performance of the leak test at the back table. The incidence and sites of bleeding from the IVC after reperfusion were recorded prospectively, and the efficacy of the leak test was thus assessed. The requirement for blood products between groups was compared using the chi-square test. All protocols were approved by our institution's ethics committee and conform with the ethical guidelines of the 1975 Helsinki Declaration. Written informed consent was obtained from all study participants.

Technique of Modified Back Table Procedure with Leak Test

The donor organ is inspected by the transplant surgeon to confirm its degree of steatosis and suitability [3]. It is then examined, with particular attention paid to the vascular anatomy: not infrequently, we have found arterial anomalies or vascular injuries that were not detected at the time of organ procurement. The surgeon performing the back table procedure creates an ice slurry bath from four 1-liter bags of frozen lactated Ringer's solution. The transport fluid (Marshall's solution) is added to this slurry in the back table basin. The donor liver is covered with cold wet swabs to protect the liver from direct contact with ice to avoid freezing of the liver tissue. This cold preservative bath should maintain the tissue temperature at 0-4°C [1].

Mosquito forceps are applied to the corners of the suprahepatic and infrahepatic IVC, aortic patch, portal vein, and tissue around the bile duct. Dissection is started on the posterior aspect of the supra-

hepatic IVC and continues down to the infrahepatic IVC, dividing the ligament of the IVC in the process. Sufficient width of the posterior cava is mobilized to facilitate the cavocavostomy, and this usually can be achieved without dividing any venous tributaries that drain the caudate lobe. The diaphragmatic and fatty tissues around the suprahepatic IVC are carefully dissected: there are usually 1-2 small phrenic veins on the right and 1-2 larger veins on the left that are ligated at this stage. A Watson Cheyne probe can help in identifying these branches. The left hepatic vein is thin-walled and is prone to injury during this dissection. The right adrenal vein is ligated at the infrahepatic IVC, and the adrenal gland is removed [1].

The arterial inflow is dissected from the aortic patch to the level of bifurcation of the gastroduodenal artery, cleaning off the coeliac plexus and fibrofatty tissue enveloping the vessels. The superior mesenteric artery should be examined carefully to detect an accessory right hepatic artery [4]. The portal vein is dissected to the level of its bifurcation, and 1-2 small tributaries are ligated. The vein is then filled with bath fluid and tested for any points of leakage, which are oversewn with 5-0 Prolene. We prefer to prepare the biliary tract in the recipient after reperfusion to prevent its devascularization [1].

The upper end of the IVC is closed with 4-0 Prolene continuous sutures. Before completely closing the infrahepatic IVC, 80 mL of cold bath solution is flushed into the IVC to check for leakage from branches and suture lines. All detected points of leakage are oversewn with 5-0 Prolene. The test is then repeated until no further leaks can be identified, and the infrahepatic IVC is then closed.

Results

The 25 patients who underwent standard OLT form a control group, as the leak test was not possible in these patients. There were 11 patients in this group who required further sutures for bleeding from the IVC, and 9 (36%) of these were due to small branches that were missed at the back table. Thirteen of 30 (43%) patients who underwent MPT without leak testing had small caval branches that needed suturing after reperfusion (Figure 1).

There were 57 patients who underwent MPT with a leak test at the back table procedure. In 20 (35%) of them, a leak was identified at the back table and was controlled. None of these 20 patients had

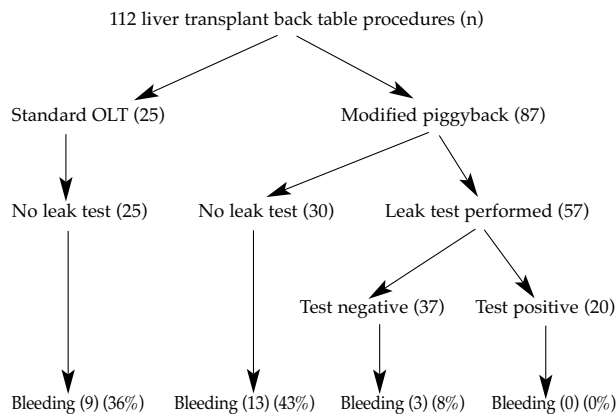


Figure 1. Efficacy of Leak Test in Preventing Caval Bleeding

caval bleeding after reperfusion, confirming the efficacy of this test when positive. Of the 37 patients in whom no leak could be detected at the back table, 3 (8%) subsequently had bleeding from the IVC that necessitated suturing. However, 1 of these patients also had primary graft nonfunction with profound coagulopathy and generalized ooze—it was unclear whether the bleeding was due to a missed branch at the back table.

In summary, missed caval branches were identified and needed suturing in 23 (41.8%) of 55 patients who did not have a leak test. When the back table procedure was performed with a leak test, this identified 20 such points of potential bleeding and missed only 3 (6%) of 57 cases. However, no significant difference was present in the requirement for blood products between the groups.

Overall sensitivity, specificity, and diagnostic accuracy of the leak test are shown in Table 1.

Table 1. Overall Sensitivity, Specificity, and Accuracy of the Leak Test in the Modified Piggyback Technique for Liver Transplantation

Avoid bleeding	Test positive	Test negative
Yes	19	35
No	0	3

Sensitivity	19/19 (100%)
Specificity	35/38 (92.1%)
Accuracy	54/57 (94.7%)

Discussion

The IVC of the donor liver is prepared for transplantation on the bench. This involves cleaning off excess tissues and ligating the venous tributaries [1,2,4]. There are 3-5 small phrenic veins draining into the suprahepatic IVC and sometimes into one of the hepatic veins. These require careful identification and control; failure to do so will lead to bleeding from these tributaries after reperfusion. It will then be necessary to mobilize the liver to identify and suture these bleeding sites. Unnecessary liver mobilization not only increases the risk of ischemia to the new liver but also strains the vascular anastomotic sites and can result in further bleeding. This may prolong the operation time and increase operative blood loss.

No previous data exist in the literature on the incidence of missed venous tributaries causing troublesome hemorrhage, but the present study has shown it to be as high as 33%. We also failed to find any description of the back table procedure for the piggyback technique of liver transplantation.

Conclusions

There is a significant incidence of bleeding from small branches of the IVC, seen in approximately 40% of cases. Nearly all of them can be successfully identified and controlled at the back table by performing a leak test, as described here. This correlates with a dramatic decrease in bleeding from the IVC after reperfusion and avoids mobilizing the reperfused liver. Although there is no demonstrable decrease in the blood transfusion requirement, we recommend the leak test to transplant surgeons who use the modified piggyback procedure.

References

1. Ferla G, Colledan M, Doglia M, Fassati LR, Gridelli B, Rossi G, et al. Back-table surgery for liver grafts. *Transplant Proc* 1988; 20: 1003-1004
2. Casavilla A, Gordon RD, Starzl TE. 2000 Techniques of liver transplantation. In: Blumgart LH, Fong Y, eds. *Surgery of the Liver and Biliary Tract*. Volume 2. 3rd ed. Philadelphia, WB Saunders; 2000, pp 2155-2180
3. Schenk M, Zipfel A, Sauer U, Lauchart W, Viebahn R. The quality of a liver graft. *Transpl Int* 2000; 13(suppl 1): S288-S290
4. Todo S, Makowka L, Tzakis AG, Marsh JW Jr, Karrer FM, Armany M, et al. Hepatic artery in liver transplantation. *Transplant Proc* 1987; 19: 2406-2411