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The Spectrum of Portal Vein Thrombosis in Liver Transplantation

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Thrombosis of the portal vein with or without patency of its tributaries used to be a contraindication to orthotopic liver transplantation (OLTX) until quite recently. Rapid progress in the surgical technique of OLTX in the last few years has demonstrated that most patients with portal vein thrombosis can be safely and successfully transplanted. Presented here is a series of 34 patients with portal vein thrombosis transplanted at the University of Pittsburgh since 1984. The various techniques used to treat various forms of thrombosis are described. The survival rate for this series was 67.6% (23 of 34 patients). Survival was best for patients who underwent phlebothrombectomy or placement of a jump graft from the superior mesenteric vein. The survival rate also correlated with the amount of blood required for transfusion during surgery. Overall it is concluded that a vast majority of the patients with thrombosis of the portal system can be technically transplanted and that their survival rate is comparable to that of patients with patent portal vein.

THROMBOSIS OF THE portal vein (PV) and/or its tributaries (portal system) has been a formidable challenge in orthotopic liver transplantation (OLTX). Although this complication of end-stage liver disease was once a relative contraindication to OLTX if known in advance,[1-3] the need to treat unexpected thromboses uncovered during operation soon led to the development of venous grafting procedures.[4,5] During the last few years, we used increasingly sophisticated techniques to treat splanchnic venous thrombosis, thereby widening the indications for OLTX. Presently almost all patients with portal system thrombosis, even of very extensive nature, can have orthotopic transplantation.

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Methods

Surgical Techniques

If portal system thrombosis is suspected before operation or discovered at the time of transplantation, venogram can be obtained by cannulating one of the branches of the ileocolic vein or the inferior mesenteric vein (Fig. 1). Accurate knowledge of the patient's anatomy is essential to plan subsequent steps. One of the deviations from normal practice is the use of a single venovenous bypass (femoral to axillary vein), omitting the usual decompression of the splanchnic system during the anhepatic phase.[6,7]

The extent of the thrombosis may vary from segmental of the PV only (Fig. 2A) to extremely extensive, with involvement of all the major splanchnic veins (Fig. 2D). If the segmental thrombosis is high enough that the portal vein can be encircled and clamped superior to the pancreas (Fig. 3), the usual venous anastomosis can be performed (Fig. 4A) or a short interposition vein graft from the donor liver can be inserted (Fig. 4B). Efforts at this encirclement can be hazardous, especially if this is near the retropancreatic confluence of the superior mesenteric vein (SMV) and splenic vein (SV). Hemorrhage during such a dissection forced us, in two cases, to transect the pancreas and ultimately to replace the PV and SMV with donor vein grafts (Fig. 5). Iliac veins are harvested routinely from the liver donors and they can prove life saving under these circumstances.

An alternative technique, and one that is more applicable to extensive thromboses, is a jump graft from the

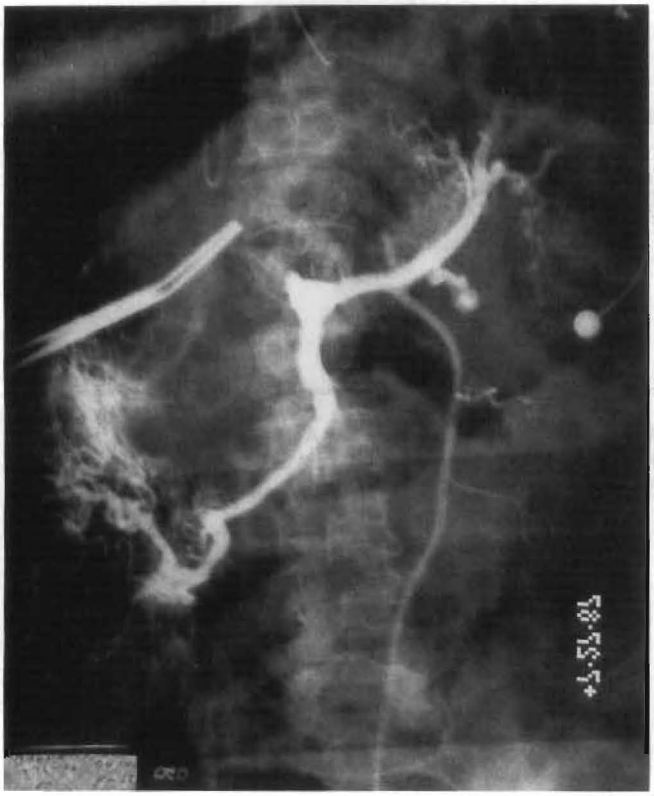


FIG. 1. Portal system angiogram performed through a catheter inserted in the inferior mesenteric vein, showing complete thrombosis of the portal vein.

superior mesenteric vein or one of its tributaries.[8,9] This is our preferred approach for the complex thromboses shown in Figure 2B to D. The method can be used even if there has been previous thrombosis of the SMV, providing there is recanalization and enough normal wall to allow an anastomosis. A free segment of donor iliac vein, including the common and external portions, is anastomosed end-to-side to the SMV, then tunneled through the avascular window anterior to the pancreas, beneath the pylorus and into the hepatic hilum. The tunnel can be either to the right or left of the middle colic vein, depending on the straightest route. This graft can then be anastomosed easily to the donor's portal vein (Fig. 6). In some of our early cases, this graft was brought through the natural infrapancreatic tunnel after teasing out the thrombosed SMV, but hemorrhage from the bed (Fig. 5) was too uncontrolled for this to be practical.

Even if there has been previous thrombosis of the PV and recanalization with thickening of the walls (Fig. 7), such a vessel can be satisfactory for venous anastomosis, providing the flow is good. However very careful suturing is required because the abnormal wall of the recipient PV can be not only friable but also subject to layer separation. Perfect apposition of the endothelium of the two vessels is mandatory in what may be considered to be a circumferential intimorrhaphy (Figure 8A and B). Flushing of the recanalized PV with heparinized saline solution and

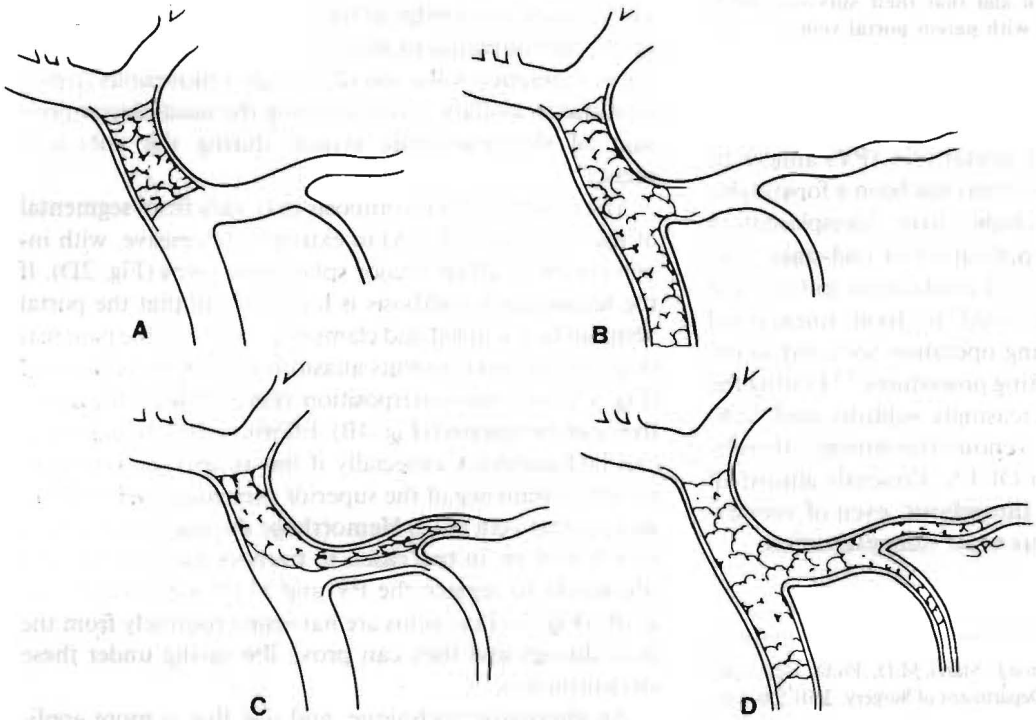


FIG. 2. The different types of thrombosis of the portal vein and its tributaries are shown.

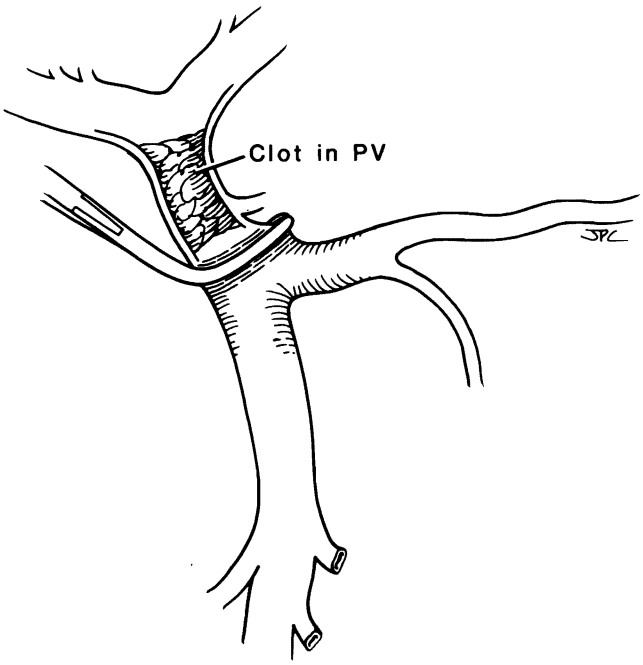


FIG. 3. Position of the portal clamp at the confluence of the superior mesenteric (SMV) and splenic (SV) veins in thrombosis of the portal vein only.

probing with Fogarty or Foley catheters may be indicated before anastomosis and/or before restoring flow to the liver.

If all the major splanchnic vessels (PV, SMV, and SV) are thrombosed (Fig. 2D), the situation may still be rectifiable. If a very large coronary vein is present, the donor's PV can be anastomosed in an end-to-side fashion to this vessel (Fig. 9). This procedure was first performed on a patient 6 years ago who is still well. Alternatively a venous collateral can be anastomosed by a bridge vein graft to the liver portal vein (Fig. 10) if the flow is inadequate after phlebothrombectomy and other efforts.

In one patient whose portal flow was still considered subobtimal, the graft portal was arterialized from the donor's splenic artery stump (Fig. 11). This is a well-known experimental procedure[10] that has been used clinically to arterialize the central portal vein after completely diverting portocaval shunt.[11,12] The outcome in our patient was excellent, with the patient becoming perfectly well 10 months later.

When not even a large coronary vein is present, division of the portal vein high in the liver hilum and extensive embolectomy can usually establish sufficient portal flow for revascularization of the donor liver. The embolectomy is performed with a combination of scissor dissection, use of ring clamps, and Fogarty and/or Foley catheters (Figs. 12 to 14). The portal system is then flushed extensively with heparinized saline to remove lose thrombus and prevent rethrombosis during cross-clamping.

Patient Material

At the University of Pittsburgh 1585 patients were transplanted between April 1, 1986 and October 31, 1989. Of these, 34 patients (2.1%) had thrombosis of the portal vein. Fourteen patients (41.2%) had postnecrotic cirrhosis, 8 patients (23.5%) had Laennec's cirrhosis, 3 patients (8.8%) had cryptogenic or autoimmune hepatitis, and 2

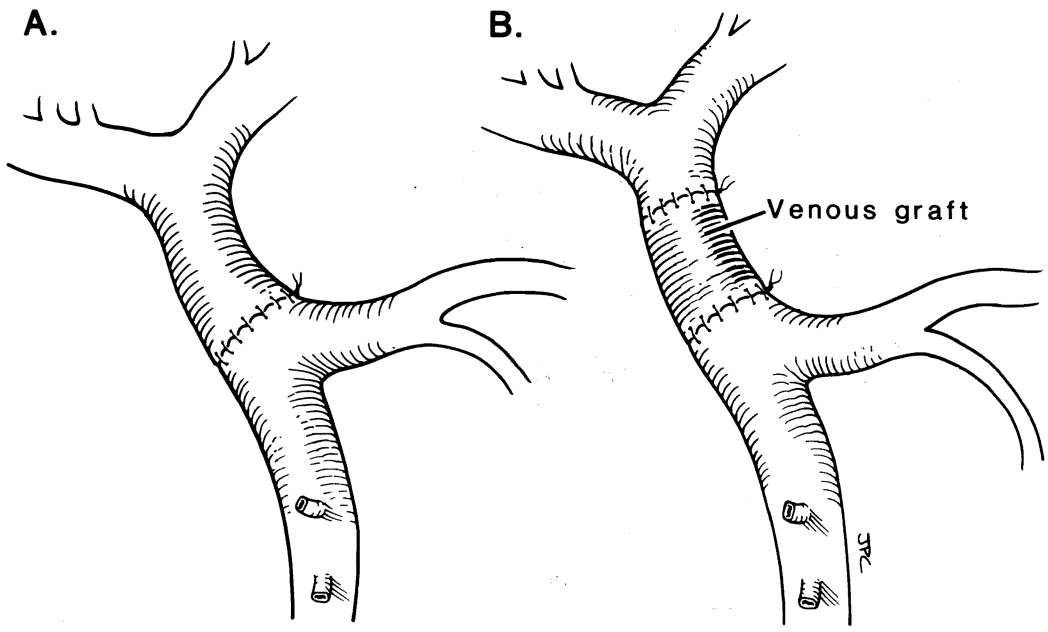


FIG. 4. (A) Direct anastomosis of the donor portal vein to the recipient confluence of the SMV and SV (B) Short free vein interposition graft used between the donor and recipient's portal veins.

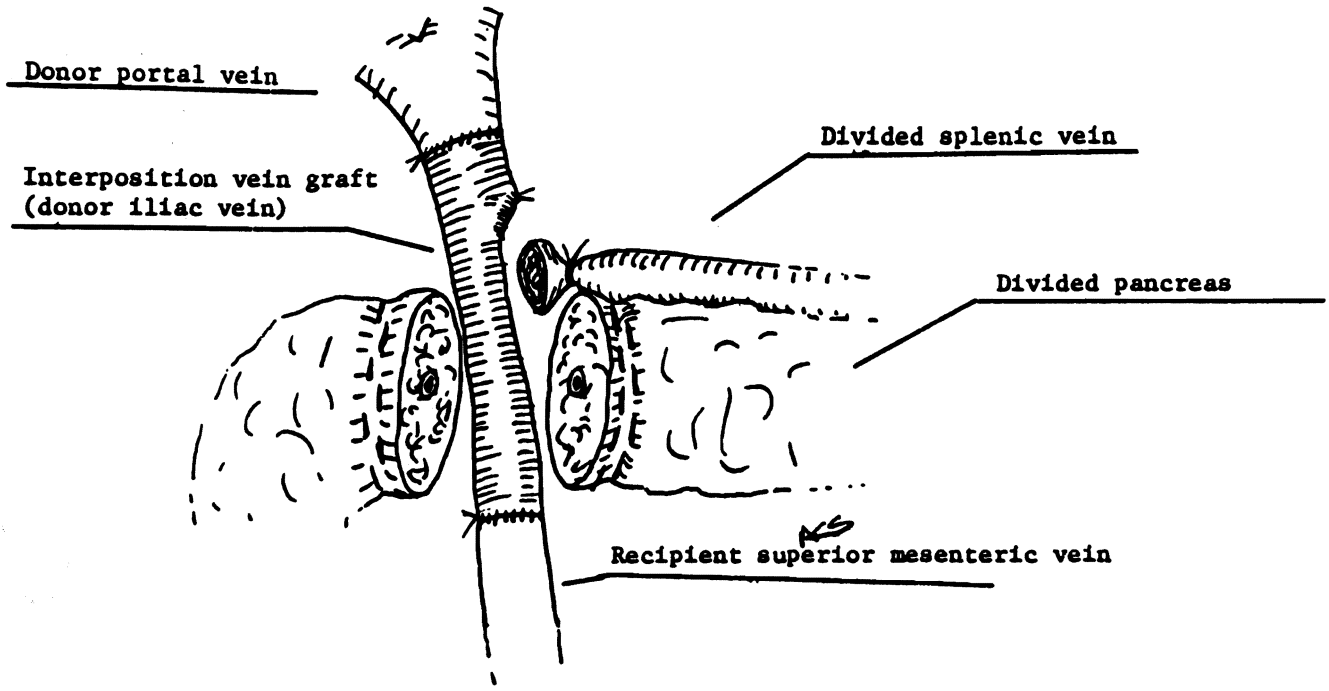


FIG. 5. Division of the pancreas for access to the retropancreatic superior mesenteric vein, with placement of a free interposition vein graft.

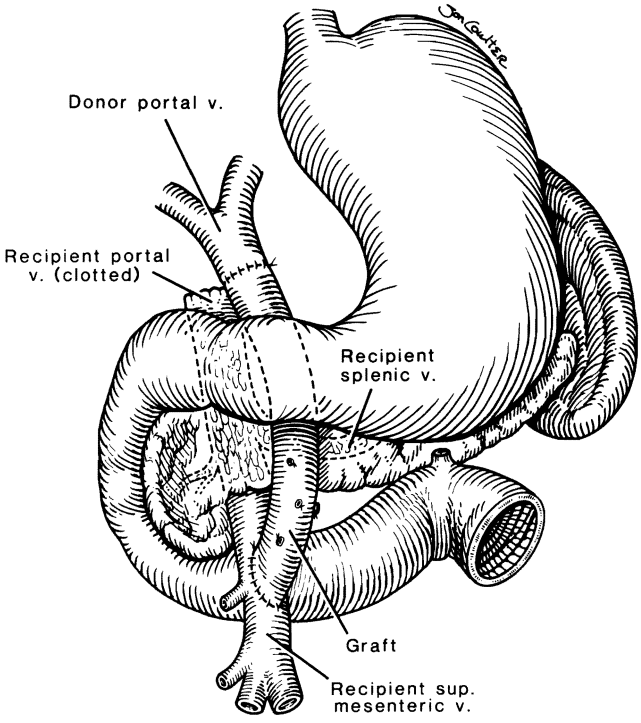


FIG. 6. Venous jump graft, from the infrapancreatic superior mesenteric vein into the donor portal vein, tunnelled in between the pancreas and the pylorus.

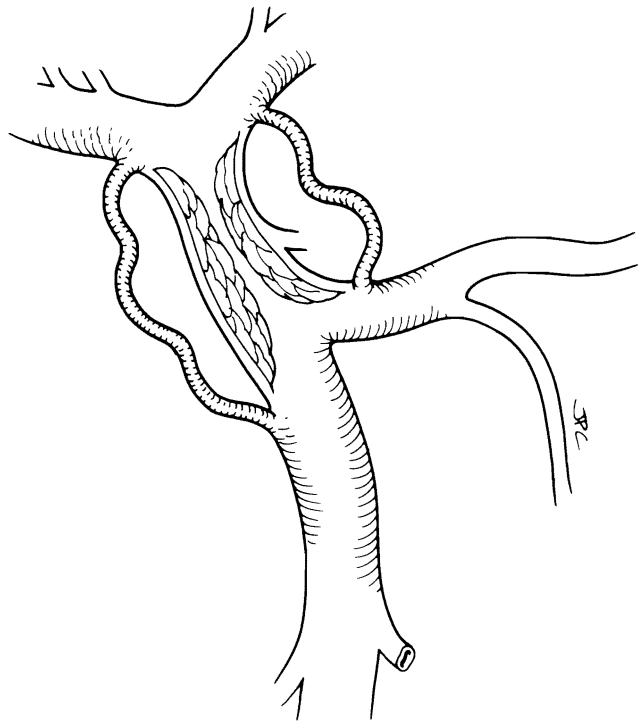
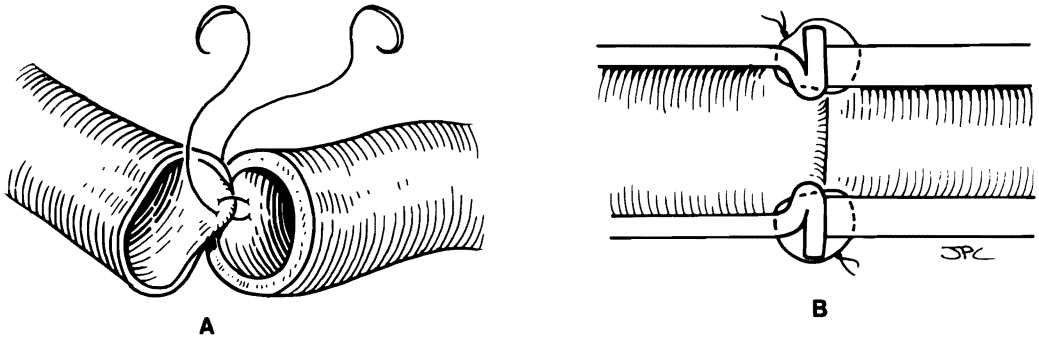


FIG. 7. Cavernomatous transformation of a thrombosed portal vein.



FIGS. 8A and B. Both A and B show details of the anastomosis of a normal, thin-walled donor portal vein to a thick-walled recipient portal vein.

patients (5.9%) had congenital biliary atresia and primary sclerosing cholangitis. Congenital hepatitis, primary biliary cirrhosis, secondary biliary cirrhosis, hemochromatosis with associated hepatoma, and Wilson's disease with a previous distal splenorenal shunt were found in five patients (2.9%) (one condition in each patient). The preoperative sonographic examination of the liver with Doppler probe accurately diagnosed the portal vein thrombosis in only 16 (47.1%) patients. In 15 other patients of the entire transplant population (1%), a false-positive report of portal vein thrombosis was not verified at the time of transplantation.

Results

Twenty three (67.6%) of the patients had thrombosis of the portal vein only with sparing of the confluence of the SV and SMV (group 1). Seventeen (73.9%) of these patients survived. In contrast, the survival rate was only 6 (54.5%) of the 11 patients who had extensive thromboses of the distal splanchnic systems (group 2; Fig. 15). One of the deaths in group 1 was from recurrent hepatoma 6 months later. The recurrence had invaded and reoccluded the portal vein.

Two of the eleven deaths in the whole group occurred during the operation. Mortality was correlated with blood loss, which ranged from 4 to 160 units (mean 35.6 ± 40.6 SD). Seventeen of twenty patients (85%) survived the operation when less then 30 units of blood were given compared to 7 of 14 patients (50%) with transfusions greater than this ($p < 0.005$; Fig. 15).

The venous jump grafts were successful in 11 of 14 cases (78.6%) compared to only 8 of 13 cases (61.5%) when direct thrombectomy or interposition grafts were used (Fig. 15). In five patients with extensive thrombosis

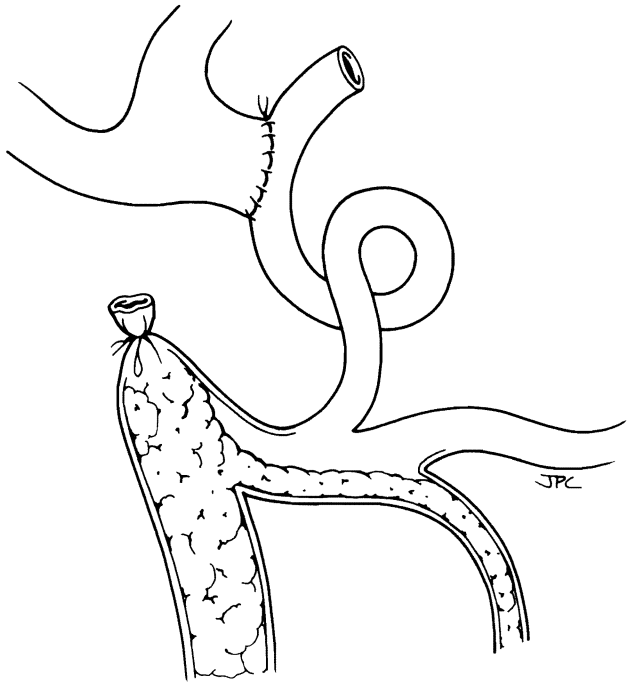


FIG. 9. Anastomosis of the donor portal vein to a large patent recipient coronary vein in the case of an extensive thrombosis of the portal system.

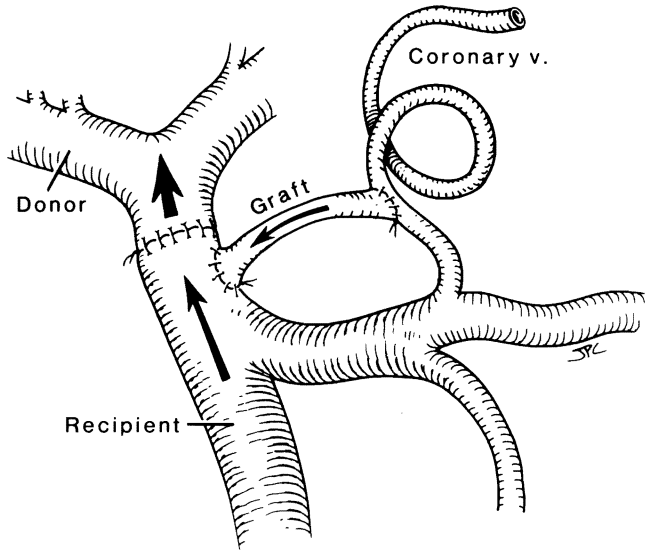


FIG. 10. Interposition vein graft between the recipient coronary vein and either the recipient's or the donor's portal vein, intended to increase the flow through the portal system.

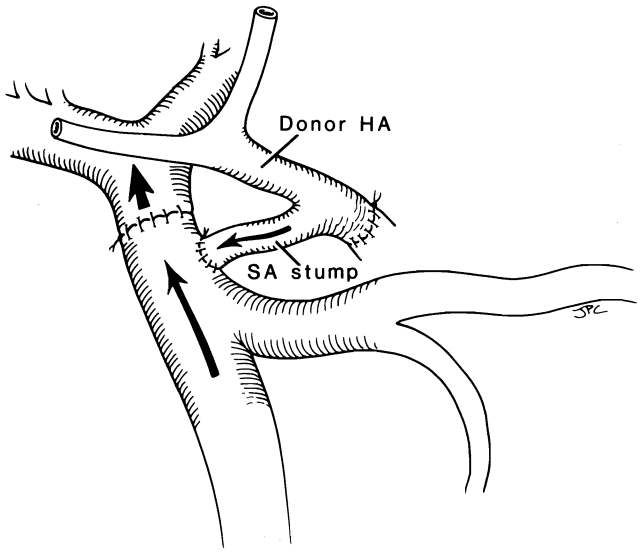


FIG. 11. Arterilization of the portal vein using the stump of the donor splenic artery.

of the mesenteric system in which declotting of the portal vein and its tributaries as well as anticoagulation were used, the survival rate was 100%. Although encouraging, the number of these high-risk patients is too small to allow conclusions about this form of treatment. The remaining two patients were excluded because they died during operation.

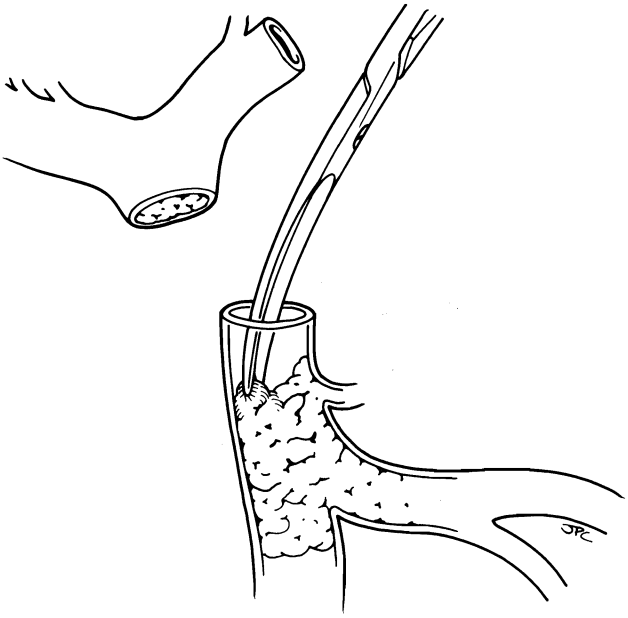


FIG. 12. In extensive thrombosis of the portal system, phlebothrombectomy can be accomplished, first by using sharp dissection with scissors.

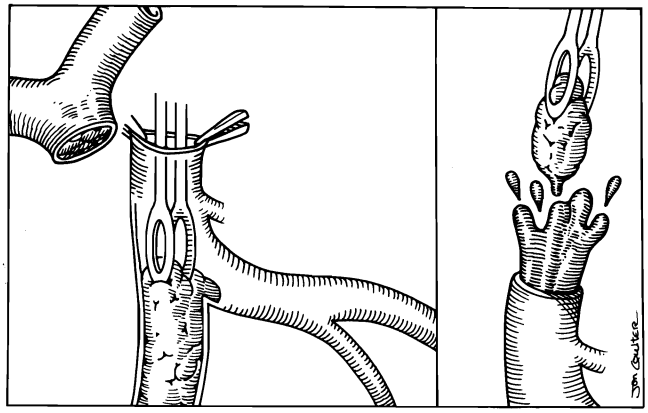


FIG. 13. The phlebothrombectomy is continued with the use of a ring clamp that can grab either hard or soft thrombus and safely remove it.

Discussion

This experience illustrates how a major technical hurdle in OLTX was overcome using increasingly simple solutions to the problems that actually have become more complex. This tendency toward streamlining is evident in all of the technical aspects of liver transplantation.

Most PV thromboses occurred in patients with postnecrotic cirrhosis. Unexpected thromboses were found most commonly in patients with severely shrunken livers and in those with sudden deterioration after a period of seeming clinical stability. Negative ultrasound reports frequently were erroneous. Patients with Laennec's cirrhosis are also at high risk for PV thrombosis. Before the availability of transplantation, the incidence of this complication was said to be about 11%[13]; however more recent studies suggest that the incidence is only 0.5%.[14] Portal vein thrombosis may be more common in male patients.

In our series, the extent of the thrombosis appeared to influence the outcome, as did the amount of blood needed at operation. That these two variable are parallel is not surprising because the technical difficulties posed by extensive venous disease can come close to the ultimate challenge. However some of the most serious hemorrhages occurred in patients whose thromboses did not extend into the SV or SMV. In earlier days, great efforts were made to dissect back to the open confluence of these vessels for placement of interposition grafts. This necessitated invasion of the superior pancreatic area, which, under these circumstances, is especially rich in collaterals. Today we abandon these efforts early if they prove to be difficult in favor of an extra-anatomic jump graft from the SMV. The consequences since 1987 have been better patient and graft survival and a reduced incidence of post-transplant pancreatitis. Our recent experience with five patients who were beyond help even with jump graft techniques has been encouraging. These patients who underwent

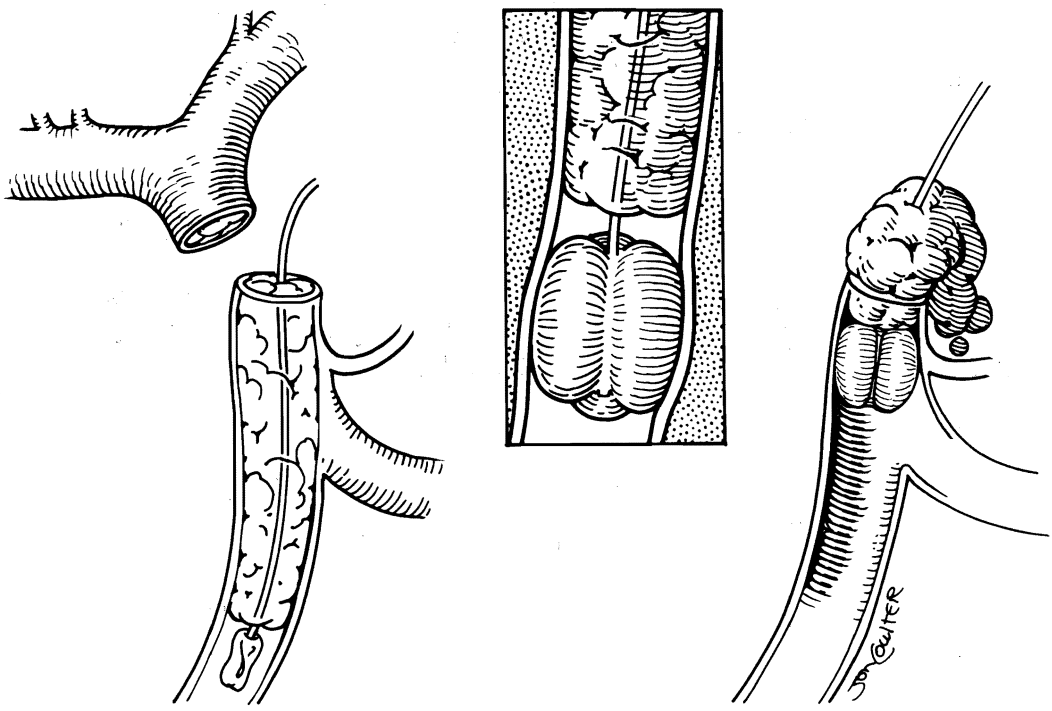


FIG. 14. Another alternative for the phlebothrombectomy is the use of Fogarty balloon catheters or Foley catheters.

thrombectomies and make-shift procedures (including central portal arterialization) and later anticoagulation may be better candidates than we previously realized.

An algorhithm has been developed for approaching portal vein thrombosis (Fig. 16). This algorhithm permits a flexible approach to the operation that can be modified on the basis of the sometimes unexpected findings that are encountered. It is possible that almost all patients with portal system thrombosis can undergo successful liver replacement.

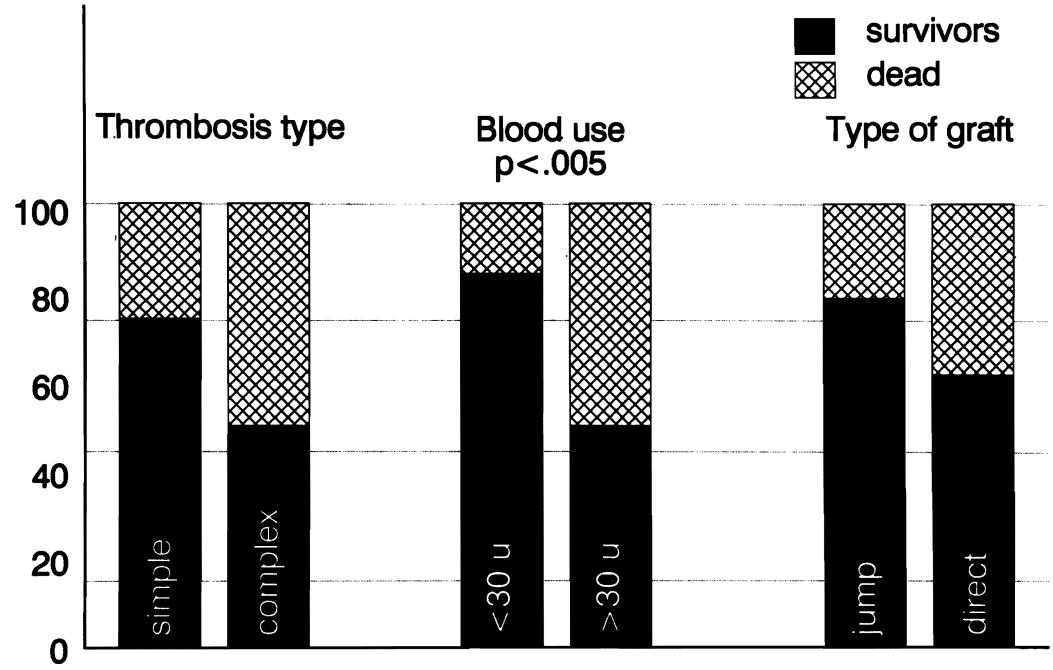


FIG. 15. Difference in survival depending on thrombosis type, blood loss, and type of graft.

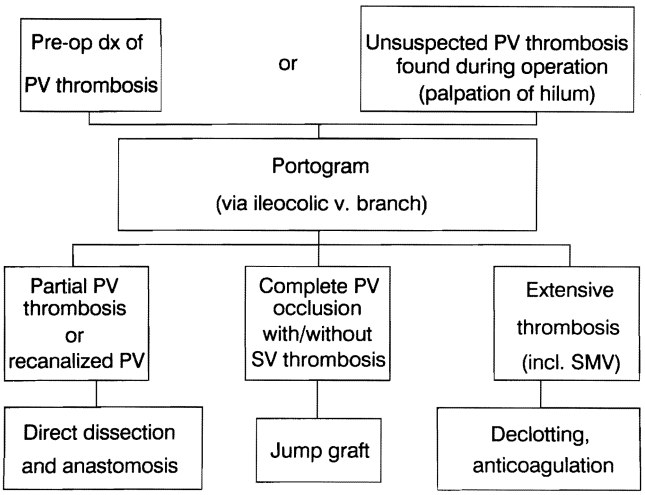


FIG. 16. Algorithm for approaching patients with PV thrombosis.

Acknowledgment

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