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Combination harvesting procedure for liver and whole pancreas

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Abstract. Combination harvesting procedures for the liver and whole pancreas can be carried out successfully in most instances, but this requires agreement between the liver and pancreas teams concerning the vascular supply for the grafts. If one donor team is in charge of both organs, the procedure has considerable economical advantages. Even if one organ is not suitable, partial success is sufficient to compensate for the effort and costs.

Key words: Multiorgan procurement - Pancreas transplantation - Liver transplantation.

The increasing demand for transplantable organs has resulted in the necessity for optimal utilization of multiorgan donors. Although harvesting of the heart, liver, and kidneys is more frequent than in the past, including the pancreas in a multiorgan harvesting procedure has been accepted with reluctance. In particular, procuring the whole pancreas together with the liver is considered to be anatomically impossible [1] or at least to present a major obstacle. Although segmental pancreas transplantation is used by many centers, we and others currently prefer exclusively techniques that use the whole pancreas with a duodenal segment. The main reasons for this preference are that the transplanted islet cell mass is larger and has greater functional reserve and that these procedures seem to be easier surgically and to be safer for the patient.

The donor selection criteria for the pancreas are not yet uniform. Most centers insist on stable donors with normal or near-normal serum chemistry. The presence of shock or a history of shock of unknown duration or severity are relative contraindications for pancreas procurement [5]. Graft thrombosis or possible sequelae of graft ischemia, e.g., pseudocyst and graft pancreatitis, are thought to be caused, at least in part, by preexisting donor hypoperfusion.

Liver donors are usually accepted on the basis of their past history, laboratory results, and circulatory stability [6]. They are, therefore, a good choice for pancreas donors as well. In addition, the consent of their relatives is usually obtained for multiorgan procurement. Pancreas procurement should therefore only be a minor addition to the multiorgan harvest event.

In an attempt to facilitate the combination harvesting procedure, we have tried to work out the problems occurring in the donor and recipient centers. Observations and opinions are reported as well as the results in attempted and completed combination harvesting procedures for the liver and whole pancreas. The economic impact of such combination procedures is also calculated. Our viewpoint is the result of our group's commitment to liver, kidney, and pancreas transplantation, together with close cooperation with the local heart-transplant team.

Techniques

The donor operations were done by surgeons with extensive experience in liver and kidney procurement. The majority were done in remote donor hospitals. Dissection was carefully done to obtain complete anatomical information in the following sequence: midline laparotomy and sternotomy; division of the triangular ligaments of the liver; dissection of the lesser omentum to identify additional arteries or replacing left hepatic arteries;

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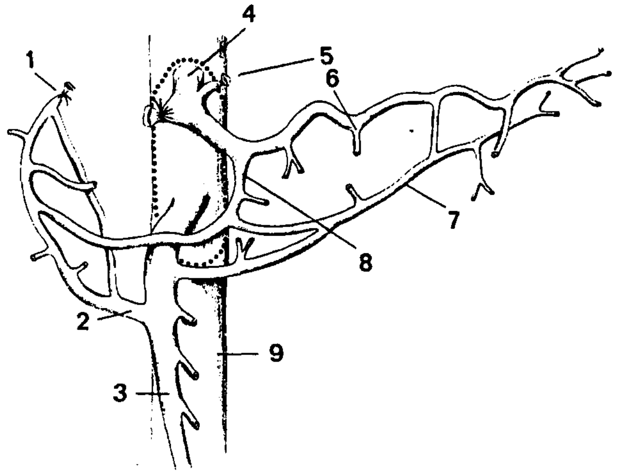

Fig. 1. Arterial supply of a whole pancreas graft after liver procurement (celiac axis remained with pancreas in most instances). Note the critical collaterals: dorsal pancreatic artery and inferior pancreatoduodenal artery. *1* Gastroduodenal artery, *2* inferior pancreaticoduodenal artery, *3* superior mesenteric artery, *4* celiac trunk, *5* left gastric artery, *6* splenic artery, *7* transverse pancreatic artery, *8* dorsal pancreatic artery, *9* aorta

exposure of the retroperitoneal vessels, including the superior mesenteric artery; dissection of the origins of the gastroduodenal, common hepatic, and splenic arteries; exposure of the aorta proximal to the the celiac axis; trans-section of the gastrocolic ligament, splenocolic ligament and short gastric vessels; identification of the superior mesenteric vein.

Excessive and time-consuming preparation was avoided. After sufficient exposure, decisions were made as to whether all organs could be used and how the arterial and venous supply should be divided (see Fig. 1). In situ perfusion and storage of the abdominal organs with Euro-Collins was always done, leaving the portal vein intact. After cannulation of the mesenteric vein (or a major branch thereof) and the aorta, perfusion was done simultaneously, using two perfusion systems. After 1000 ml of aortic perfusion, bulldog clamps were placed on the origins of the superior mesenteric and splenic arteries in order to avoid overperfusion of the pancreas. Back-pressure into the portal systems was minimized by complete decompression of the inferior vena cava in the pericardium and inferior to the renal veins. After perfusion, the duodenum was stapled and cut using a GIA device. For the sake of convenience, the distal suture line was placed near the ligament of Treitz in the donor center. The inferior horizontal part of the duodenum was later removed during the bench operation. The aorta was divided longitudinally, starting at its bifurcation. Arterial patches could be precisely cut by optimal intra-aortic exposure. Final dissection and preparation of the liver and pancreas were done on the back table in the local operating room.

Results

Donor operations

On the basis of telephone information, combination liver and pancreas procurement was planned in 13 instances. On 8 occasions it was actually completed. The reasons for not doing the combination procedure were:

Unstable donor: 1 (liver and heart-lung used)

Unexpected spleen injury: 1 (liver used)

Anatomical reasons: 1 (liver used)

Last-minute failure to obtain an intensive care bed for the pancreas recipient: 1 (liver used)

Previous splenectomy and extensive adhesions in an obese donor: 1 (donor used for heart and kidney)

Liver firm and fatty: 1 (pancreas used)

In all cases heart and kidneys were used for transplantation as well.

Recipient operations

Eleven livers and 8 whole-pancreas grafts were harvested and transplanted in addition to 13 hearts and 26 kidneys. Six pancreas grafts had initial function; 2 of them needed short-term insulin supplementation under standard glucose infusions of 400 g/day for strict control of euglycemia. One pancreas thrombosed 24 h after uneventful surgery. Its function could not be evaluated. One pancreas had poor reperfusion; reexploration after 11 h revealed total graft thrombosis. This is thought to be the result of an unacceptable donor (see below).

Nine of 11 livers transplanted had excellent or acceptable graft function. Two livers had initial nonfunction. The patients required urgent retransplantation, which was possible in both cases. Reevaluation of one donor revealed the presence of severe shock after the lethal trauma. This was unknown to us during the organ procurement. Poor liver function and a thrombosed pancreas graft are thought to be the consequences of this inappropriate donor condition. The second liver with initial nonfunction was harvested from a stable donor. It appeared to be somewhat firm during the donor operation. Reperfusion was sluggish. Although the graft was viable, its function was insufficient. The cause of graft failure is not known.

Two donors were not accepted for liver donation because of the gross pathological appearance of the liver: pale and patchy, probably due to shock and fatty changes. At the time of procurement, parenchymal disease could not be excluded. One donor was nevertheless found suitable for pancreas donation.

Vascular supply

After agreement between the members of our team, it was decided that the celiac axis would be left with the whole pancreas in all cases except one, in which the arterial supply of the liver was very limited (small diameter). In this case, the arterial supply of the pancreas was reconstructed with an iliac artery graft to the splenic and superior mesenteric arteries. Other techniques for reconstructions have been suggested or published [3]. Arterial anastomosis in the liver recipient was carried out using various techniques described in the literature. No complications from vascular anastomosis have resulted in the liver recipients. The portal vein was always long enough for the liver. For 3 patients the portal vein of the pancreas was extended by an iliac vein graft. Recent experience indicates, however, that even a short portal vein is long enough if the recipient's iliac vein is sufficiently mobilized.

Financial implications

Aside from donor availability, approximately DM 20,000 for air and ground transportation has already been saved. In addition, in the context of four distant donor operations, time-consuming traveling by the donor team has been avoided. The combination donor procedure has increased the flexibility of our transplant team, allowing us to save manpower for recipient operations.

Precautions and limitations

Multiple small arteries to the liver, arising from the celiac axis and the superior mesenteric artery, remain an obstacle to combination liver and whole-pancreas removal. This occurred in 1 donor in this series. Reconstruction of small vessels is probably an excessive risk for the liver recipient. Ligation of the gastroduodenal artery can be carried out safely (Fig. 1). In this case, it is of the utmost importance that an adequate collateral supply be maintained and the origin of the inferior pancreatoduodenal arcade be kept intact (Fig. 1). Lesions of these critical structures can be avoided by leaving the retropancreatic tissue and the origin of the first jejunal arteries intact. The dorsal pancreatic artery (Fig. 1) may have various origins [5] and can be easily damaged. It should be preserved if identified. An arterial supply by a single, large hepatic artery originating from the superior mesenteric artery and crossing the pancreas should not be a contraindication for combination harvesting, because such an artery can be easily reconstructed for the liver.

Discussion

Optimal utilization of a stable multiorgan donor is already being attempted by several groups in western Europe and the United States. Increasing demands for pancreas grafts have resulted in attempts at combination liver and segmental pancreas harvesting procedures. Several pancreas transplant groups prefer the techniques using the whole gland with a duodenal segment. The technical advantage claimed by several groups [2, 7] has led to an increase in the frequency of whole-pancreas transplantation. In most instances, a combination harvesting procedure can safely be carried out - even if an atypical arterial supply is found. The basis for successful completion is the willingness of the liver and pancreas teams to agree on optimal anatomical solutions for *both* organs. Because pancreas dissection adds to the operating time, this procedure is not recommended for unstable donors. It may jeopardize the quality of the liver and heart. On the other hand, the complexity of anatomical considerations requires dissection of the critical vascular structures before perfusion to allow for optimal decisions with respect to vascular supply of the transplanted organs. The rapid flush perfusion technique suggested by Starzl et al. [8] does not allow proper calculation of vessel size, which is necessary for decision making.

We have not accepted Corry et al.'s suggestion [2] of dividing the portal vein to avoid back-pressure to the pancreas and thus avoid graft edema. This practice is an obstacle to combination harvesting procedures and may be based on negative experience with excessive perfusion volume or pressure. In our opinion, this is not essential. The liver does not seem to cause much pressure build-up if the vena cava is completely decompressed. Excessive portal pressure is also avoided by limiting the portal perfusion pressure to 40 cm of water. The portal system could also be decompressed by incision of the inferior mesenteric vein or the distal splenic vein in the splenic hilum. Another approach, although a little awkward, could be a perfusion cannula for the portal vein inserted into the superior mesenteric vein and pushed up into the portal vein. There it can be secured with a tourniquet around the portal vein. Free splenic vein drainage is achieved by retrograde flow (R. Margreiter, personal communication). Pancreas edema is also probably reduced if limited quantities of perfusion solution are used. We tried to achieve this by arterial occlusion with bulldog clamps on the splenic and superior mesenteric artery after 1000 ml of aortic perfusion. The ease of in situ perfusion has led us so far to use Euro-Collins solution for perfusion and storage. This has been the standard preservation procedure for the liver and kidneys in our region and has facilitated the introduction and acceptance of the combination procedure. New and better perfusion solutions may improve graft quality and allow for a longer ischemia time. This may lead to an overall improvement in pancreas transplantation by the possibility of tissue matching and easier operation room scheduling.

Pancreas transplantation is not specifically funded in many countries, which forces us and others to conduct pancreas transplant procedures as efficiently and economically as possible. Saving on money for traveling and manpower may facilitate the expansion of pancreas transplant programs in the future.

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