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Logistics and Technique for Procurement of Intestinal, Pancreatic, and Hepatic Grafts From the Same Donor

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Objective

To assess a technique for simultaneous recovery of the intestine, pancreas, and liver from the same donor.

Summary Background Data

With the more frequent use of pancreatic and intestinal transplantation, a procurement procedure is needed that permits retrieval of both organs as well as the liver from the same cadaveric donor for transplantation to different recipients. It is believed by many procurement officers and surgeons, however, that this objective is not technically feasible.

Methods

A technique for simultaneous recovery of the intestine, pancreas, and liver was used in 13 multiorgan cadaver donors during a 26-month period, with transplantation of the organs to 33 recipients. The intestine was removed from 11 donors separately and in continuity with the pancreas in the other 2. Six additional pancreases were excised and transplanted separately. Thirteen livers were retrieved, one of which was discarded because of steahorrhea. Ten of the remaining 12 livers were transplanted intact; the other 2 were split in situ and used as reduced-size hepatic allografts in four recipients.

Results

None of the 11 intestinal, 6 pancreatic, 2 intestinal–pancreatic, or 14 whole or partial liver allografts sustained serious ischemic injury or were lost as a result of technical complications. One liver recipient died 25 months after surgery of recurrent C virus hepatitis. The other 32 recipients had adequate allograft function with a mean follow-up of 8 months.

Conclusion

It was possible using the described technique to retrieve intestine, pancreas, and liver allografts safely from the same donor and to transplant these organs to different recipients.

With the improved results of both intestinal and pancreas transplantation with tacrolimus-based immunosuppression,[1–6] there has been a commensurately increased demand for these procedures. However, it has been suggested that both organs cannot be obtained from the same cadaveric donor, particularly if the liver also is to be transplanted. The argument has been that because the three organs share an axial blood supply (Fig. 1), they cannot all be assured of an adequate blood supply when detached from each other and transplanted individually.[7] Contrary to this assumption, we describe here how the technical challenge was met in a series of 13 consecutive cadaveric donors whose organs were used to treat 33 recipients of hepatic (n = 14), intestinal (n = 13), and pancreas allografts (n = 8).

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METHODS

Case Material

The 13 multiple organ procurements were performed between April 20, 1997, and July 1, 1999, using previously delineated principles of multiple organ procurement.[8–10] All donors were hemodynamically stable, receiving minimal or

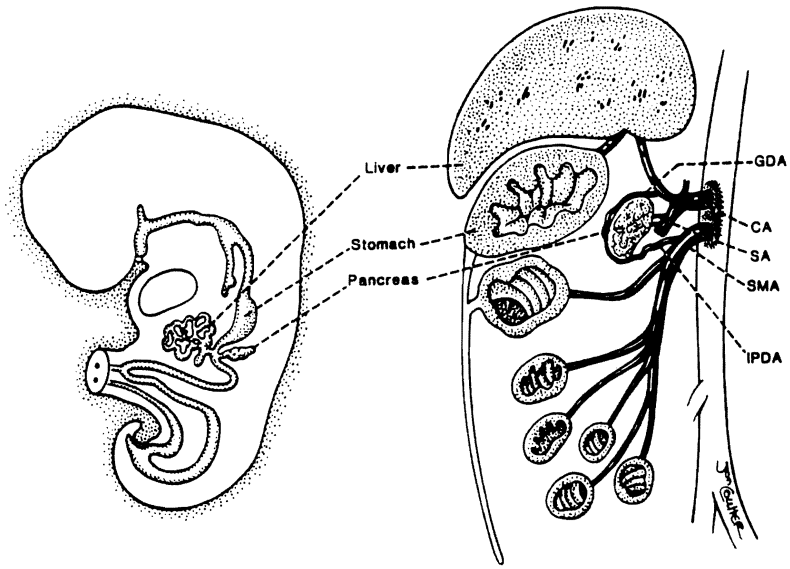

Figure 1. The embryonic origin of the liver, pancreas, and alimentary canal. Note the shared axial blood supply and its segmental distribution. CA, celiac axis; GDA, gastroduodenal artery; IPDA, inferior pancreaticoduodenal artery; SA, splenic artery; SMA, superior mesenteric artery.

no intravenous doses of vasopressors, and with normal levels of blood sugars and serum lipases and with normal results of liver function tests. Because of the frequent need for vascular conduits with intestinal and pancreatic transplantation, the other abdominal organ-sharing centers were contacted at the time of donor acceptance and were notified of our need for arterial and venous grafts.

In addition, a commitment was obtained from the participating teams to conform to the surgical strategy herein described. This was critical because many of the surgeons were from geographically dispersed areas, and essentially all had an organ-specific interest. Six of the 13 donors were in our region, and the remaining 7 were from three other United Network of Organ Sharing (UNOS) regions (Table 1). Median donor age was 22 years (range 2–46). Nine donors were adults and four were children. All organs were transplanted to ABO-identical recipients. Human leukocyte antigen matching with the recipients was random.

For intestinal transplantation, donors were selected who were lighter in weight than the proposed recipients to ensure simple closure of the abdominal wound. Recipients with negative serology for cytomegalovirus were given grafts from cytomegalovirus-negative donors. Recipient follow-up was to July 15, 1999.

Donor Preparation

Selective gut decontamination was attempted in all donors with an antibiotic preparation (amphotericin B/mycostatin, tobramycin/gentamicin, and polymyxin E) adminis-

Table 1. DONOR DEMOGRAPHICS AND ALLOGRAFT COLD ISCHEMIA TIMES

Donor	UNOS Region	Date of Retrieval	Age (yr)	Cold Ischemia Time (hr)		
				Intestine	Pancreas	Liver
1	10	4/20/97	46	8	9.0	10.2
2	2	11/14/97	27	11.5	11.5	8.1–8.7*
3	7	12/22/98	2	8	Discarded	5.1
4	2	4/18/98	37	9	21.8	8.8–7*
5	7	6/30/98	16	7.5	12	7.1
6	2	8/8/98	22	10	16.8	4.5
7	11	11/26/98	5.9	8	Discarded	12.9
8	2	12/8/98	20	6.2	Discarded	7.8
9	11	12/30/98	22	9	15	7.5
10	7	3 3/26/99	41	8.5	Discarded	Discarded
11	2	5/7/99	27.7	7.8	Discarded	6.5
12	2	6/5/99	18.9	7.8	18	15.3
13	11	7/1/99	8	12	12	15.8

UNOS, United Network of Organ Sharing.
* Split liver allograft.

tered through a nasogastric tube without lavage soon after acceptance into donorship and again at the time of donor surgery. In addition, standard intravenous antibiotic prophylaxis was instituted with cefotaxime and ampicillin.

The grafts were not altered with irradiation, antilymphoid antibody treatment, or other modalities before or after interruption of their blood flow. The recipient surgical procedure was begun only after receiving assurance from the donor team that the organs and circumstances of procurement were satisfactory. University of Wisconsin (UW) solution was used for both in situ flushing and cold storage. The mean cold ischemia time was 8.7 ± 1.6 hours for the intestine, 14.5 ± 3.9 hours for the pancreas, and 9.0 ± 3.3 hours for the liver (see Table 1).

Surgical Procedure

With the wide exposure afforded by a cruciate abdominal incision, it is possible to assess quickly the gross features of the candidate organs and the presence of vascular anomalies. If conditions are conducive to organ donation, the abdominal aorta is encircled distally for the eventual insertion of an infusion cannula. The abdominal aorta is also encircled above the celiac axis for later cross-clamping when chilled fluid is infused through the distal aortic cannula.

The procedure continues in three successive phases[8,9]: variable dissection with an intact donor circulation of the organs to be used; in situ cooling by aortic infusion of the subdiaphragmatic organs with simultaneous exsanguination, as abdominal and thoracic organs are removed; and preparation of the individual organs for transplantation on the back table. Providing there is early control of the aorta, phase 1 can be terminated at any time with prompt institution of phase 2 with essentially no penalty of warm ischemia.

Phase 1: Dissection With Intact Circulation

The exact order of the organ dissections in phase 1 is not fixed, but the following is a prototypical sequence.

Small Intestine. Soon after entering the abdomen, the small bowel is wrapped in a laparotomy pad. The first step in its removal is detachment from the large bowel. This is most conveniently done by performing total colectomy. The cecum and ascending colon are mobilized and devascularized, taking pains to preserve the ileal branches of the ileocolic artery. The ileum is then divided and closed with the GIA stapler (United States Surgical Corporation, Norwalk, CT) near the ileocecal valve. The entire colon is devascularized by ligating and dividing the middle colic, left colic, and inferior mesenteric arteries near their origin. After transection of the gastrocolic ligament and transection of the stapled sigmoid colon, the large bowel and greater omentum in continuity are removed from the field.

With gentle upward retraction of the wrapped small bowel, the root of the small intestinal mesentery is freed from its avascular retroperitoneal attachments. The mesenteric root, the abdominal aorta, and the infrahepatic vena cava, including entry of the renal veins, are further exposed with an extended Kocher maneuver. When this dissection is completed, the highest jejunal vascular arcades are divided close to the jejunal wall. Although the first jejunal trunk may be sacrificed later, the vascular supply to the fourth part of the duodenum and the proximal part of the jejunum is preserved at this early stage. The proximal jejunum is now transected after obtaining further mobilization by dividing the ligament of Treitz and the inferior mesenteric vein. The jejunal end of the intestine is marked with a long suture to aid orientation of the allograft at the time of implantation.

At this juncture, the intestine is attached to the donor only by the superior mesenteric pedicle, containing the superior mesenteric artery (SMA) and the superior mesenteric vein (SMV). These vessels are exposed by transversely dividing the anterior peritoneal sheath of the mesenteric root, distal to the level of the ligated middle colic vessels. By extending the anterior peritoneal incision laterally and dividing numerous small venous tributaries and arterial branches, short segments of the main trunks of both the superior mesenteric vessels are freed.

The foremost concern during this dissection is avoiding injury to the inferior pancreaticoduodenal artery, which originates just proximal to the origin of the middle colic artery and must be left intact with the pancreas (Fig. 2). The reason is that the superior pancreaticoduodenal artery is the terminal branch of the gastroduodenal artery that is ligated while removing the liver. The additional loss of the inferior pancreaticoduodenal artery will devascularize the head and part of the uncinate process of the pancreas. The risk of damaging the inferior vessel is minimized by limiting the dissection of the SMA to a level just proximal to the origin of the first jejunal trunk.

Exposure of the posterior wall of the SMV and SMA is unnecessary at this stage and may lead to inadvertent ischemic injury of both the liver and intestine. If posterior dissection is considered mandatory for any reason, it can be done after all the viscera to be transplanted have been cooled in situ, during removal of the intestine. Alternatively, this dissection can be done on the back table after extirpating the liver, pancreas, and small bowel en bloc. In fact, removal of all three organs as a unit is the preferred option if the donor becomes unstable or if collaborating procurement teams insist on proceeding too quickly. In 2 of the 13 donors of the series reported herein, the en bloc technique was performed electively because the recipients needed a composite intestinal–pancreatic graft.

Liver. The common hepatic artery, which is one of the three principal branches of the celiac axis, normally carries the entire arterial supply of the liver. However, the other two celiac branches (splenic and left gastric arteries) and branches of the SMA may provide some or all of the hepatic arterial supply. All such anomalous hepatic arteries are "replacement" end arteries (not accessory) and must be preserved. Thus, both before and after dividing the suspensory ligaments of the liver, it is imperative to rule out such anatomical vari-

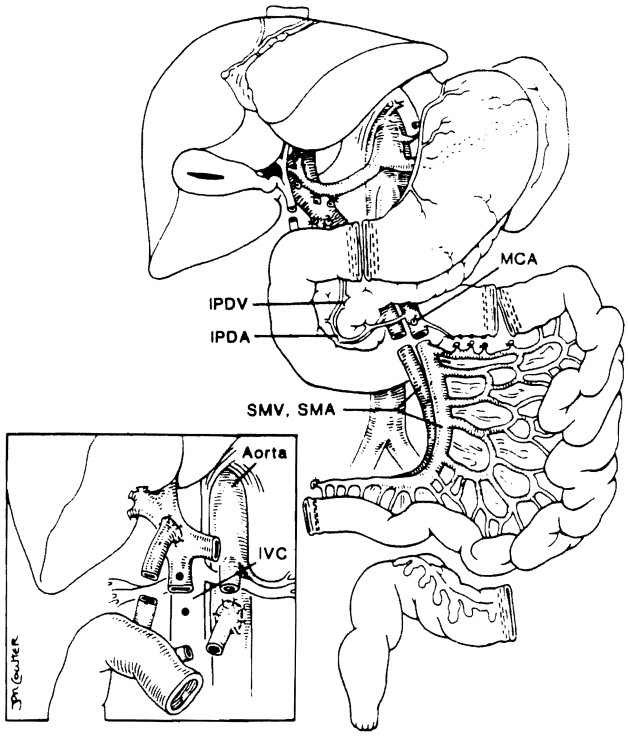

Figure 2. In situ separation of the intestinal graft and dissection of the superior mesenteric pedicle. Note preservation of both the inferior pancreaticoduodenal artery (IPDA) and inferior pancreaticoduodenal vein (IPDV) with the pancreatic graft by limiting the dissection of the superior mesenteric vessels (SMV, SMA) below the level of the ligated middle colic artery (MCA). The vascular conduits for the intestinal allograft are anastomosed to the recipient infrarenal aorta and portal vein or inferior vena cava (IVC) rather than to the mesenteric vessels at the back table (inset).

ations. If the common hepatic or right hepatic arteries originate from the SMA, such "replacement arteries" usually are found directly posterior to the portal vein.

The common bile duct is distally ligated and transected. The gallbladder is incised and the bile is washed out. After incision of the gastrohepatic ligament and division of the right gastric and gastroduodenal arteries, the pylorus is transected using the GIA stapler. The left gastric artery is ligated close to the gastric wall, taking care to preserve an anomalous left hepatic arterial branch if one is found. If the whole liver is to be removed, no further hepatic hilar dissection with the circulation intact is necessary. However, when the liver is to be shared by the recipients, as in 2 of the 13 donors in this series, the "liver split" procedure is now performed with an intact circulation, as described elsewhere.[11]

Pancreas. With this technique, the pancreas always is removed in continuity with the liver and separation is not begun until the composite specimen has been moved to the back table. Moreover, if the preparation of the small intestine below and the liver above has been properly done, the pancreas in between requires no phase I dissection. The pancreas and the segment of duodenum through which pancreatic exocrine secretions will be drained are adequately vascularized by branches of the inferior pancreaticoduodenal artery and by the splenic artery.

Phase 2: In Situ Cooling and Removal of Organs

After completion of the preliminary dissections, the donor is fully heparinized and the distal aortic cannula is placed. Chilled UW solution is infused after the previously encircled supraceliac aorta is cross-clamped. The transaortic cooling requires 2 to 3 L UW solution for adults and 50 to 100 mL/kg for pediatric donors. If the liver team elects to perform portal venous infusion, this can be done through a separately cannulated inferior mesenteric vein, but this is not mandatory.

The venous beds are decompressed by a venotomy of the suprahepatic vena cava. The total amount of infusate is guided by blanching of the organs and estimation by palpation of the degree of cooling. It is important to avoid both venous hypertension and overperfusion of the intestine and pancreas. Therefore, in situ perfusion through the portal vein or one of its tributaries is not recommended. If the intestine does not feel cold after limited perfusion, this is no cause for concern, providing it is blanched. In any event, further surface cooling after immersion in cold fluid is rapid because the intestine is a hollow organ.

The organs remain in situ until the cold infusion is complete. Then, the small intestinal graft is removed first from the surgical field by transection of the dissected segment of the SMA and SMV below the origin of the inferior pancreaticoduodenal artery (see Fig. 2). If cardiovascular instability of the donor has necessitated the rapid en bloc removal of all the abdominal viscera, separation of the intestine from the liver and pancreas may be deferred until the organ composite is on the back table. Under these circumstances, the kidneys can be removed en bloc with the liver and pancreas, along with segments of abdominal aorta and IVC, for separation on a back table. No effort is made to wash out the enteric contents that remain in the intestine until its transplantation.

In contrast to the intestine, which ordinarily is removed separately, the liver and pancreas are routinely removed in continuity.[12–15] The tail, body, and head of the pancreas and the duodenum are quickly mobilized, using the retained spleen as a handle. The crucial final step is excision from the anterior aortic wall of a large Carrel patch that contains the origin of the celiac axis and SMA (Fig. 3). Before fashioning this patch, the blood supply to both kidneys must be identified and protected, as shown in Figure 3.

By dividing the left diaphragmatic crus and carefully opening the anterolateral wall of the aorta longitudinally from its thoracic portion downward, the origins of the celiac axis and SMA and the two renal arteries can be readily visualized from within the aortic lumen. The liver–pancreas specimen with a segment of inferior vena cava and the Carrel patch containing the origins of the celiac trunk and SMA is now removed from the field to an ice basin. If both

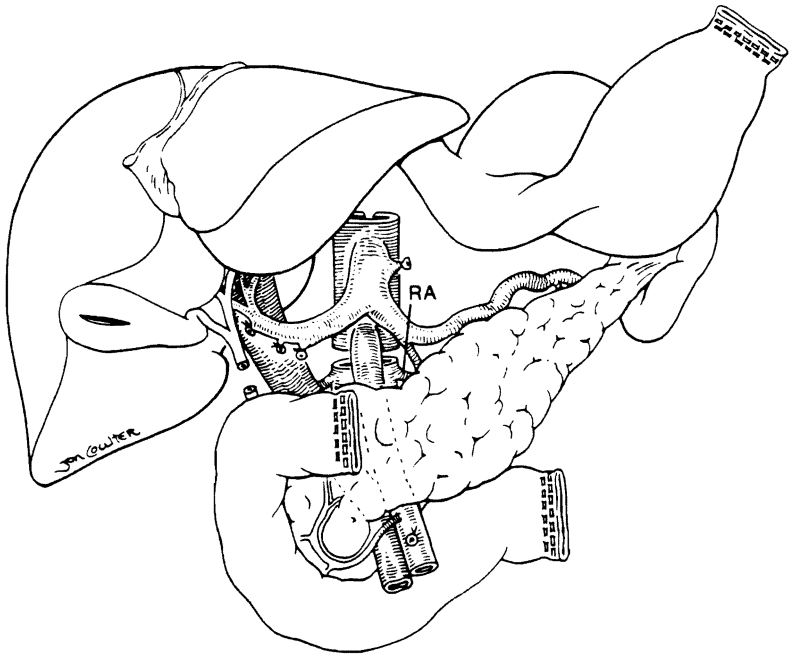

Figure 3. En bloc removal of the liver and pancreas with the duodenum and spleen. Note excision of a large Carrel patch that contains the origin of the celiac axis and superior mesenteric artery with protection of the renal arteries (RA). The spleen is removed on the back table or after reperfusion.

the liver and pancreas are destined for the same recipient hospital, the still-connected organs are placed in a plastic bag containing cold UW solution. With the abdominal viscera out of the field, the kidneys can be removed in a few minutes. The total surgical time averages 2.5 hours.

It is imperative at the end of the procurement procedures to obtain a large supply of high-quality arterial and venous grafts.[8–10] These are frequently needed for the transplantation of one, two, or even all three organs. The most commonly used vascular grafts are the iliac and carotid arteries and the iliac or jugular veins. A bifurcated iliac arterial graft is frequently required for the pancreas. The carotid artery is an ideal single conduit to lengthen either the donor or recipient SMA for intestinal transplantation.

Phase 3: Back Table Preparation of Organs

Bench work on the individual allografts is best done at the recipient hospital. Otherwise, the advantage of moment-to-moment consultation and coordination between the donor and recipient teams is lost at a critical time. However, when the pancreas and liver are transported to different transplantation centers, the ex vivo separation of the two organs must be done at the donor hospital.

Little revision of the intestinal graft is needed. If there is not enough SMA and SMV for convenient anastomosis to host vessels, cuffs can be developed by sacrificing the first jejunal branches. The resulting short segment of devascularized jejunum is delineated and resected after restoration of the allograft's blood supply. If the superior mesenteric vascular pedicle is considered too short, it is lengthened with free vascular grafts. The vascular conduits are anastomosed to the recipient infrarenal aorta and portal vein or vena cava (see Fig. 2, inset) rather than to the mesenteric vessels at the back table. This avoids having to work at close quarters around the bulky visceral allograft.

The back table separation of the liver and pancreas begins with identification of the transected distal bile duct and exposure of the subjacent portal vein down to the confluence of the SMV and splenic vein. The portal vein is transected 1 cm above this confluence, and the lower (pancreatic) end is tagged with a vascular suture for subsequent orientation. A cannula is placed in the hepatic end with which to flush the liver with 1 L cold UW solution at the end of the bench procedure.

The remaining back table procedure is dictated by the variable arterial supply of the liver and pancreas. Because all significant branches to the liver from the celiac axis and SMA are end arteries, anomalous arteries from these sources must be retained with the hepatic graft and revascularized. When this principle is observed, the pancreaticoduodenal graft is left by default with only two reliable arterial sources: the inferior pancreaticoduodenal branch of the SMA and the readily approachable splenic artery. Stretch injuries to both vessels should be avoided to prevent intimal tears, which may result in arterial thrombosis.

Unless the entire hepatic arterial supply comes from an anomalous SMA branch, the donor celiac axis and a Carrel patch is retained with the liver, and the short segment of proximal SMA remains with the pancreas. After the main trunks of the celiac axis and SMA are freed of lymphatic and neuroganglionic tissues, dissection of the celiac axis is continued distally to its trifurcation into the common hepatic, splenic, and left gastric arteries. The left gastric artery is ligated after ensuring it does not give rise to an anomalous left hepatic artery. The splenic artery is transected close to

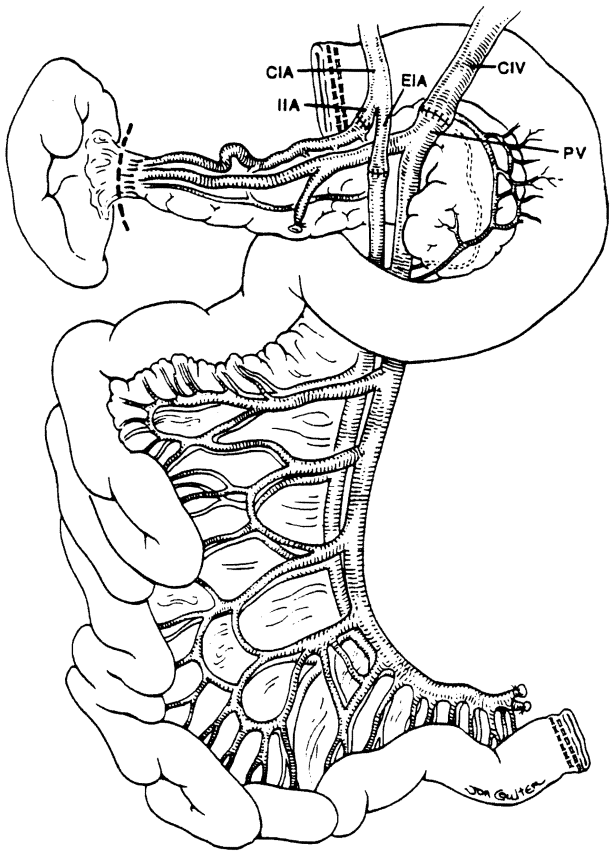

Figure 4. Back table vascular reconstruction of the composite intestinal–pancreatic allograft. Note continuity of the pancreas, duodenum, and small intestine with intact vascular pedicle. CIA, common iliac artery, CIV, common iliac vein; EIA, external iliac artery; IIA, internal iliac artery; PV, portal vein.

its origin, and the distal end is tagged with a vascular suture for later identification.

Attention is next turned to the SMA. If a replaced hepatic artery is found to arise from the SMA, the anomalous vessel almost always originates proximal to the inferior pancreaticoduodenal artery. In this circumstance, the SMA is transected between the origins of the two branches, leaving the proximal SMA in continuity with the anomalous hepatic artery and the distal SMA in continuity with the inferior pancreaticoduodenal artery.

After completion of these dissections, the celiac axis and SMA are removed as part of a common Carrel patch fashioned from the anterior wall of the aorta. The Carrel patch is then divided, leaving most if not all of it with the celiac axis. The liver and pancreas can now be completely separated by dividing the residual connecting filamentous and ganglionic tissue, which may contain a few small arterial and lymphatic vessels. The various allografts are packaged in plastic bags containing cold UW solution.

Back table vascular reconstruction was done at the recipient hospitals using techniques described elsewhere for whole[8,9] or split livers,[11] pancreas,[16–20] and intestine.[10,21] All but 2 of the 33 recipients were given single allografts. The two recipients of composite allografts had complicated medical histories. One had previously undergone total pancreatectomy and was given a donor pancreas in continuity with the small bowel (Fig. 4). The second patient, whose history included a total gastrectomy, received an allograft of the stomach, duodenum, pancreas, and small bowel (Fig. 5). The pancreas was included to facilitate transplantation of the gastroduodenal component. In these two patients, all the abdominal viscera were removed from the donors en bloc, and the livers were transplanted in other patients.

RESULTS

Intestinal Grafts

All the retrieved intestinal grafts (11 intestine-only, 1 intestine–pancreas, and the 1 modified that contained stomach, duodenum, pancreas, and intestine) were successfully transplanted in 11 adult and 2 pediatric recipients. No grafts were lost to preservation injury or technical complications. The intraoperative, perioperative, and postoperative courses of the patients were not discernibly different from recipients of intestinal grafts from nonpancreatic donors. Intestinal biopsies obtained during the first postoperative week showed evidence of mild preservation injury in only 4 of the 13 patients (Table 2), and none revealed submucosal bac-

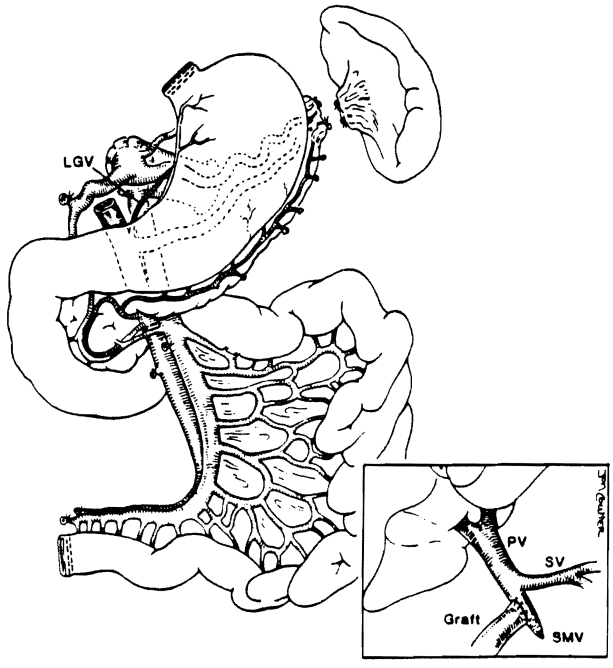

Figure 5. Modified multivisceral graft that contains stomach, duodenum, pancreas, and small intestine. Note preservation of the gastroepiploic arcade and left gastric pedicle including the left gastric vein (LGV). Inset: Venous drainage of the composite visceral graft to the side of the recipient superior mesenteric vein (SMV) stump by using the donor common iliac vein as an extension graft without compromising the recipient portal venous flow during graft implantation. PV, portal vein; SV splenic vein.

Table 2. INDICES OF ALLOGRAFT PRESERVATION AND RECOVERY

	Intestine		Pancreas (peak values, first week)		Liver (peak values, first week)		
Donor	Ischemic injury (Biopsy)	Off TPN (Postop. day)	Blood sugar (mg/dL)	Lipase (IU/L)	Total Bilirubin (mg/dL)	ALT (IU/L)	AST (IU/L)
1	+	26	185	59	9.5	865	1,513
2	+	39	261	1,671	3.2	5,075	2,931
					3.8	2,225	1,325*
3	–	NA	NA	NA	12.4	133	268
4	–	11	127	11,452	3.1	1,659	1,812
					7.8	357	292*
5	–	27	152	449	4.4	352	332
6	–	17	106	5,527	14.6	181	107
7	–	20	NA	NA	6.4	4,244	3,465
8	+	8	NA	NA	6.4	573	190
9	+	23	123	640	5.7	731	557
10	–	11	NA	NA	NA	NA	NA
11	–	10	NA	NA	4.7	889	836
12	–	24	137	1,655	8.2	746	355
13	–	14	230	1,330	1.4	1,164	467

ALT, alanine transferase; AST, aspartate transferase; TPN, total parenteral nutrition.
* Split liver allograft.

terial or fungal invasion. Blood cultures were uniformly negative during this time.

Graft absorptive and motility functions were clinically, radiologically, and endoscopically apparent within 1 to 2 weeks after surgery. Discontinuation of total parenteral nutrition (TPN) with full enteric nutritional autonomy was achieved after 8 to 39 days, except in a recipient whose graft (from donor 3) was lost to refractory rejection 30 days after transplantation. This patient developed TPN-induced liver failure after graft enterectomy and is currently waiting for a combined liver and intestinal transplant. The other 12 intestinal recipients remain free of TPN at a median follow-up of 8 months.

Pancreatic Grafts

Of 11 pancreases recovered as isolated allografts, 6 were successfully transplanted simultaneously with a kidney from the same donor to recipients with type I diabetes and renal failure. All six patients became insulin-free within 24 hours and remain so. The other isolated pancreases were discarded because of donor age (n = 2), lack of a suitable recipient (n = 2), and a technically flawed back table procedure (n = 1) (see Table 1). The two patients who received the pancreas en bloc with the intestine (donors 2, 13) required low-dose insulin therapy during the first postoperative week while receiving high doses of prednisone and TPN.

In the eight patients who received combined transplants, the serum lipase levels peaked during the first 24 to 48 hours after transplantation and fell to normal by the end of the first postoperative week (see Table 2). All eight recipients are alive and insulin-free at a median follow-up of 12 months.

Liver Grafts

Of the 15 liver allografts (11 full, 4 split), 14 were successfully transplanted to nine adult and five pediatric recipients. The remaining graft (a whole organ) was discarded because of significant macro- and microvesicular steatosis (see Table 1). The arterial reconstruction for the two left lateral segment grafts was performed using microsurgical technique.

All liver grafts functioned immediately, with serum bilirubin and transaminase levels peaking on the first postoperative day (see Table 2) and falling rapidly thereafter to normal levels. Prothrombin times became normal within 3 days. Thirteen of the 14 liver recipients are alive at a median follow-up of 8 months. The remaining patient died 25 months after whole liver transplantation of graft failure caused by recurrent hepatitis C.

DISCUSSION

With each new kind of organ transplantation, questions about adding another organ to the procurement list for a given donor have been raised. These questions have been posed first from an ethical but ultimately from a technical perspective. Until the 1980s, a "cadaveric donor" was essentially synonymous with a kidney donor. When better immunosuppression brought transplantation of liver, heart, and other extrarenal organs to a practical level, the osten-

sibly ethical concern of many kidney transplant surgeons was whether removal of multiple organs would result in damage to the renal allografts.

Such anxieties were allayed by the development of procurement procedures that were flexible enough to allow the excision of all the organs above and below the diaphragm without jeopardizing any of the individual grafts.[8,9] The overarching principle was the avoidance of warm ischemia. This was done by core cooling of all the candidate organs by the intravascular infusion of chilled fluids into the aorta at the time of circulatory arrest, combined with proximal aortic cross-clamping at preplanned levels.

The simplicity and efficiency of these techniques ensured their acceptance as a world-wide standard. However, it was initially thought that removal of the whole pancreas for transplantation would be incompatible with procurement of the liver, because both procedures originally called for retention of the celiac axis and portal vein with the respective allografts. Because transplantation of the pancreas was an option for most diabetic patients, whereas liver recipients do not have an alternative form of treatment comparable to insulin administration, pancreas transplantation was at first restricted to circumstances in which the livers could not be used. The policy was promptly rendered obsolete by sophisticated techniques of vascular reconstruction[16–20] and methods of en bloc removal of the pancreas and liver.[12–15]

More recently, a similar unwarranted conclusion has been that the liver, pancreas, and small intestine cannot be removed for separate transplantation. The results of the present series demonstrate the fallacy of this opinion. The simultaneous retrieval of the intestine, pancreas, and liver from the same donor was shown to be routinely feasible, using modifications of the standard methods. To do this safely, it is necessary to have detailed knowledge of the vascular anatomy of all three organs. The single most important detail is retention of the inferior pancreaticoduodenal vessels with the pancreas during removal of an isolated intestinal or hepatic graft. If sacrifice of the first jejunal artery and vein is required during removal of the intestine, the only penalty is amputation of the upper few centimeters of devascularized intestine. Second, it must be understood that the splenic artery will be the only other vessel used to arterialize the pancreatic allograft. Consequently, this vessel also must be assiduously protected and anastomosed.

One of the frequently expressed concerns with adding the intestine to multiple organ procurement is the possibility of contaminating the hepatic, pancreatic, renal, and other grafts with enteric spillage. This risk is all but eliminated by using the stapler technique to close the small bowel allograft and residual host gastrointestinal tract proximally and distally, and also by avoiding enteric luminal flushing during the donor procedure. The intestinal, pancreatic, and liver allografts retrieved with the described technique were of excellent quality. None of the recipients lost their grafts because of intraabdominal infection, preservation injury, or a technically flawed donor procedure. There were no examples of vascular thrombosis.

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