# 39 Technical Innovation and Visceral Transplantation

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## Introduction

The improvement of outcomes after intestinal and multivisceral transplantation over the last two decades is due to multiple factors including innovations in surgical techniques [1–3]. With increased practicality, visceral transplantation has been successfully used for patients with different varieties of irreversible gastrointestinal failure. Accordingly, different combinations of en bloc abdominal visceral organ transplant have been more frequently utilized [4, 5].

All different types of small bowel containing transplants can be categorized into three main prototypes: "isolated intestinal," "liver-intestinal," and "multivisceral" transplantations. Historically, the terms "isolated intestinal" and "multivisceral" transplantation originated more than half a century ago from the pioneer respective work of Lelihie and Starzl et al. and the third prototype "liver-intestinal" has been recently introduced by Grant et al. [5, 6] (Fig. 39.1). Because of continual technical advances there has been some confusion concerning the nomenclature of these allograft combinations [7].

While intestine being the central core of visceral allograft, the term "multivisceral" is a distinctive nomenclature for stomach-contained visceral allograft. Among multivisceral transplant, "full" contains liver allograft while "modified" does not. Secondary organs include colon and the pancreaticoduodenal complex with or without spleen. Colon can be retained with any three types of visceral allografts. The pancreaticoduodenal complex is routinely part of liver-intestinal graft and can be added to intestinal grafts for the patients who need combined intestine and pancreas transplant [8, 9].

We describe herein these three main prototypes of visceral transplantation and discuss the most relevant technical modifications in both donor and recipient procedures.

## Choice of Visceral Transplant Allograft

### Isolated Intestine

Isolated intestinal transplantation is the proper choice for patients with intestinal failure without liver cirrhosis. Mild-to-moderate liver dysfunction with periportal hepatic fibrosis is not contraindication for isolated intestinal transplant particularly in patients without synthetic or vascular decompensation. Isolated intestinal graft has been more frequently used with a higher incidence in adults (55%) than children (37%) [2]. This could be partly due to the greater need for a combined liver-intestinal transplant in children as a result of a higher incidence of end-stage liver disease associated with total parenteral nutrition in this age group.

The indications for this type of transplant can be collectively divided into short bowel syndrome, motility disorders, malabsorption syndromes, and gastrointestinal neoplastic disorders. In patients with concomitant pancreatic insufficiency and intestinal failure, such as patients with cystic fibrosis, chronic pancreatitis, or diabetes mellitus, an en bloc intestine and pancreas transplant may be considered [10].

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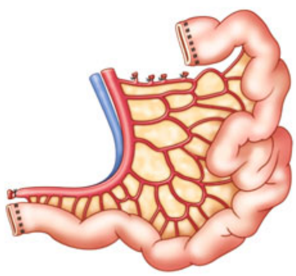
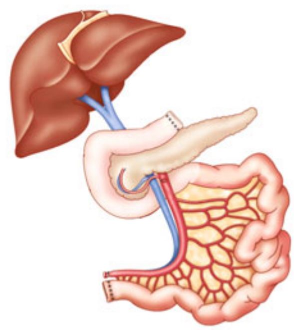
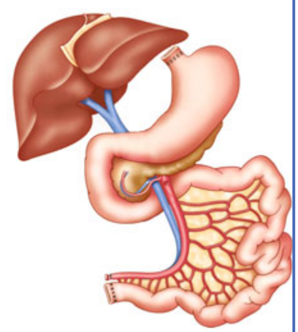
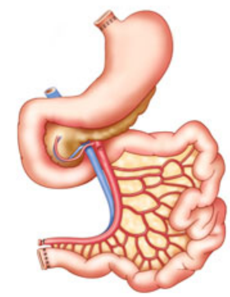
| Main Types | | | |
|---|---|---|---|
| Intestine | Liver-Intestine[1] | Multivisceral | |
| | | Full | Modified |
| | | Stomach + Duodenum + Pancreas + intestine + Liver | Stomach + Duodenum + Pancreas + intestine |
|  |  |  |  |
| **Subtypes (descriptive)[2]** | | | |
| • Intestine alone<br>• En bloc with colon and/or pancreas | • En bloc with colon and/or kidney | • En bloc with colon and/or kidney<br>• With preserved native pancreaticoduodenal complex and/or spleen | |

[1] Inclusion of the pancreaticoduodenal complex is optional and commonly utilized for technical reasons.
[2] Optional or when medically indicated.

**Fig. 39.1** The prototypes and the subtypes of visceral transplantation

## Combined Liver-Intestine

The combined liver-intestine transplantation is usually indicated for patients with intestinal failure who developed end-stage liver disease due to long-term parenteral nutrition [10, 11]. The procedure may also be indicated for patients with liver failure combined with portomesenteric venous thrombosis when isolated liver transplantation is not technically feasible.

The organs can be transplanted in a simultaneous or consequent fashion. The en bloc allograft includes the pancreaticoduodenal axis along with liver and small bowel to maintain continuity of gastrointestinal tract and integrity of axial blood supply. Pediatric or small candidates requiring combined liver and intestinal transplants may benefit from a "reduced-size liver"—small bowel graft [12] which may include left, right, or extended right lobes of the liver (Fig. 39.2).

In 2009, the senior author [3] proposed and implemented a "domino transplant procedure" in which patients with recurrent chronic rejection after isolated intestinal transplantation would receive a combined liver-intestine graft from the same donor even if they have a fully functioning native liver. The recipient native liver will be given to another candidate of liver-only transplant.

## Multivisceral

Full or modified multivisceral transplantation comprises nearly 24 % of adult and 13 % of pediatric intestinal transplants [10, 13]. It is indicated for patients with complex abdominal pathology including massive gastrointestinal polyposis, traumatic loss of the abdominal viscera, extensive abdominal desmoid tumors, locally aggressive non-metastasizing neoplasms, advanced generalized hollow visceral myopathy/neuropathy, and complete thrombosis of the splanchnic arterial or portomesenteric venous systems with hepatic decompensation [3].

From an immunological standpoint, multivisceral or combined liver-intestine transplant may have an advantage over isolated intestine transplant. The achieved better long-term engraftment with liver-contained graft compared to liver-free graft was reported by the senior author [3]. The improved outcome is mostly related to the immunoprotective effect of the concomitantly transplanted liver. This observation can be partially explained by the recently published data showing that liver-contained allografts were associated with significant clearance of preformed alloantibody and low induction of de novo donor-specific antibodies along with better survival in liver-contained allografts [14]. The study also demonstrated the important role of alloantibody in chronic visceral allograft injury and the liver can be immunoprotective with less favorable outcome in recipients with persistent alloantibodies.

## Donor Surgery

### Donor Criteria

Optimal donor selection is imperative to successful transplant outcome in intestine-contained transplantation. Prolonged downtime and the requirement for high-dose or multiple inotropes compromise the quality of visceral grafts. Other important factors include size disparity especially for recipients who lost the abdominal domain or large component of the abdominal wall. Allograft reduction in conjunction with efforts to increase abdominal domain including abdominal wall transplant and pre-transplant implementation of tissue expander in subcutaneous layer have been performed to facilitate graft coverage with newly created abdominal wall [12, 15, 16]. It is imperative to obtain arterial and venous vascular segments from the same donor to facilitate visceral allograft implantation. Accordingly, prompt initiation of communication with other abdominal organ-sharing programs is essential to facilitate smooth retrieval.

### Surgical Procedure

With an increase in the gap between organ donation and demand, a procurement procedure is needed that permits multiple-organ retrievals for separate recipients waiting for liver, pancreas, and intestinal allografts [4]. A recent advance in organ retrieval technique made it feasible to share these organs among three different recipients (Fig. 39.3). When multivisceral transplantation is required for patients with preserved liver function, modification of the technique made it possible to utilize the donor liver for one recipient and the

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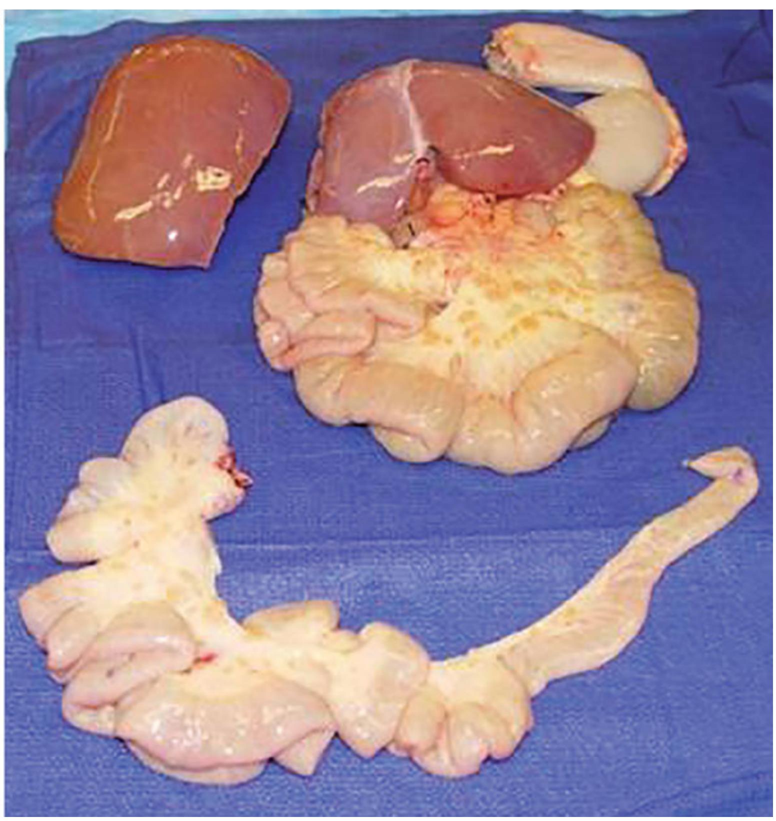


**Fig. 39.2** (**a**) A split right hepatic graft and a reduced-size multivisceral graft that contains left hepatic lobe, and reduced small intestine. (**b**) A split right trisegment hepatic graft and an en bloc composite left lateral hepatic segment and intestinal graft with a single Carrel patch of superior mesenteric and celiac arteries. The single Carrel patch is anastomosed to a conduit of donor thoracic aorta at the back table. Separate arterial and venous grafts to the right trisegment hepatic lobe. *IVC* inferior vena cava, *RPV* right portal vein, *RHA* right hepatic artery, *RHD* right hepatic duct, *CBD* common bile duct, *PV* portal vein, *HA* hepatic artery, *CA* celiac artery, *SMA* superior mesenteric artery, *SMV* superior mesenteric vein

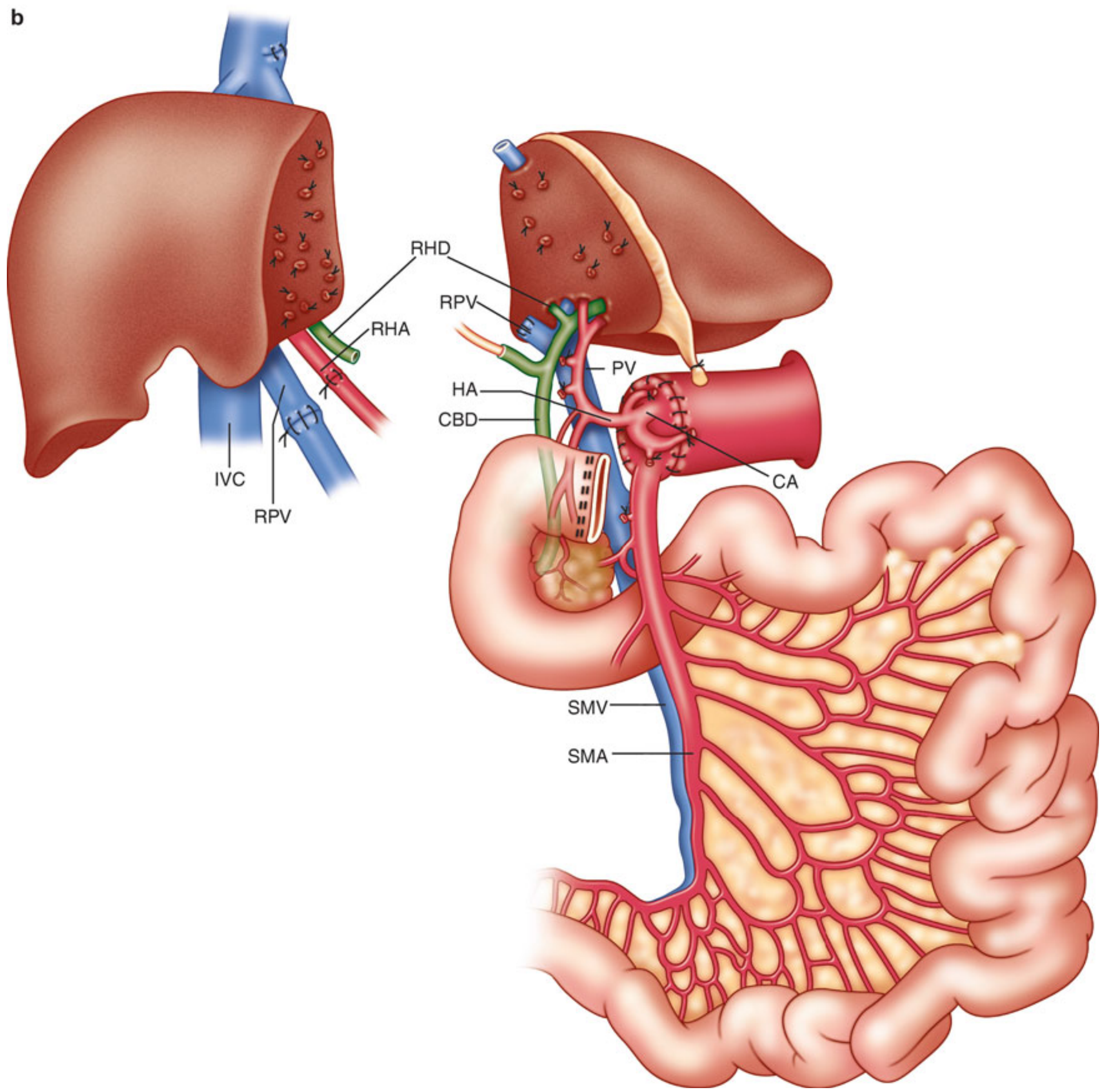



**Fig. 39.2** (continued)

remaining visceral organs to a second patient (Fig. 39.4). The term "modified' multivisceral transplantation was first introduced in 1993 and recently published by the senior author [17–19].

Upon entering the abdominal cavity, the intestine should be carefully examined. Thin mesentery with less adipose tissue is preferable because fat component is susceptible to ischemic-reperfusion injury, resulting in fat necrosis and subsequent mesenteric sclerosis after transplantation. Intestine with pneumatosis or portal venous gas is unacceptable for transplant. Iliac arteries and veins are accessed for the suitability for interposition grafts. Once quality of organ(s) is found to be satisfactory for transplant, direct communication between donor and recipient team prompts the recipient operation to minimize the cold ischemic time.

The first step of organ retrieval is performing the organ dissection with Cattel maneuver to mobilize small bowel and right colon that facilitates exposure of the vena cava and aorta [20, 21]. The left renal vein is identified with isolation of the SMA origin. Then the abdominal aorta is encircled distally for the eventual insertion of an infusion cannula. The supraceliac aorta is also encircled for later cross clamp.

After the colon and intestine are mobilized from retroperitoneum, the ileum is divided with the gastrointestinal stapler near the ileocecal valve when donor colon is not procured with the visceral organs. Right and transverse colons are detached from ileocolic vessels by taking down right and middle colic vessels. The remaining steps of the procedure are dictated by the type of required visceral allograft.

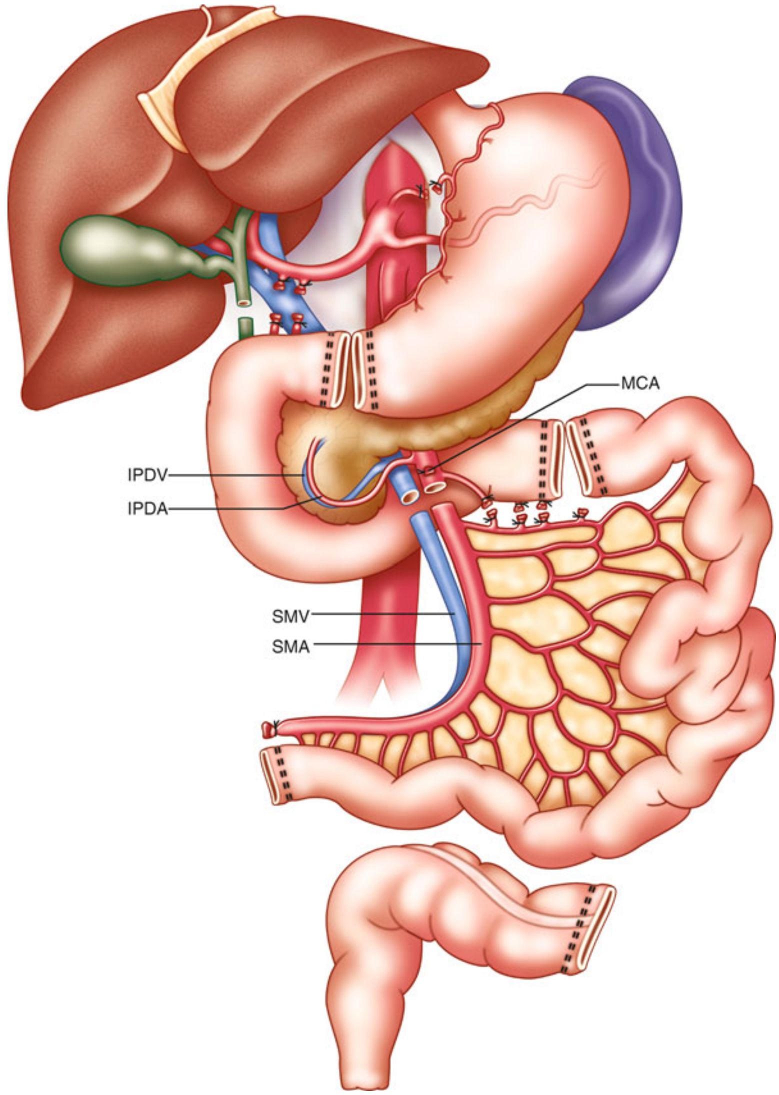



**Fig. 39.3** In situ separation of the intestinal graft and dissection of the superior mesenteric pedicle. Note preservation of both the inferior pancreaticoduodenal artery (IPDA) and inferior pancreaticoduodenal vein (IPDV) with the pancreatic graft by limiting the dissection of the superior mesenteric vessels (SMV, SMA) below the level of the ligated middle colic artery (MCA)

## Isolated Intestinal Graft

The proximal jejunum is transected at the Treitz ligament after an interruption of the inferior mesenteric vein. At this juncture, the intestine is attached to the donor only by the superior mesenteric vascular pedicle, containing the superior mesenteric artery (SMA) and 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.

When the pancreas is procured for another recipient, the inferior pancreaticoduodenal artery needs to be preserved for the pancreatic graft, which originates just proximal to the origin of the middle colic artery [4]. Because the gastroduodenal artery is transected when donor liver graft is removed, injury of the inferior pancreaticoduodenal artery will devascularize the head of the pancreas. In order to maintain sufficient arterial flow to the head of the pancreas, the SMA will be divided distal to the origin of inferior pancreaticoduodenal artery. Since the first couple of jejunal arterial branches may originate from the SMA proximal to inferior pancreaticoduodenal artery, these proximal jejunal branches may need to be sacrificed.

When the pancreas is not procured, numerous small venous and arterial pancreatic branches from superior mesenteric vessels can be divided to obtain more length of the main trunk of mesenteric vessels. Further meticulous dissection leads to the splenomesenteric confluence of the portal vein. After cross clamp and cold flushing, SMA is transected at its origin, and the SMV is transected at the splenomesenteric confluence.

## Liver-Intestinal Graft

During the initial phase of retrieval with intact circulation, the liver and small intestine should be carefully manipulated and dissected en bloc with their central vascular structure [6, 22, 23] . The proximal end of allograft was transected at

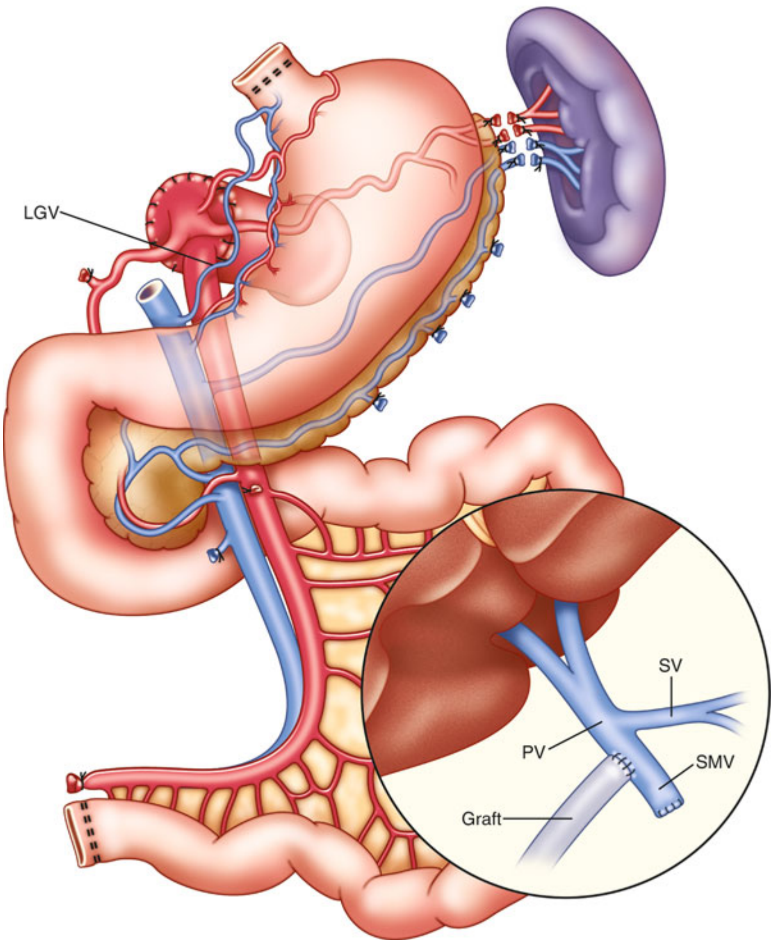



**Fig. 39.4** Modified multivisceral graft that contains stomach, duodenum, pancreas, and small intestine. Note preservation of the gastroepiploic arcade and left gastric pedicle including the left gastric vein (LGV). Inset: Venous drainage of the composite visceral graft to the side of the recipient 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

the bulb of duodenum just distal to the pylorus. Full preservation of the donor pancreaticoduodenal complex en bloc with the combined liver-intestinal graft was adopted to eliminate the need for biliary reconstruction and maintain continuity of the axial blood supply.

During the cold phase of dissection, the crucial final step in liver-intestine graft retrieval is excision of a large Carrel patch that contains both the celiac axis and SMA from anterior aortic wall without compromising the renal arteries [4]. By carefully opening the anterior wall of the aorta from its caudal portion to the root of SMA, the origins of the celiac axis and SMA and the two renal arteries can be readily visualized from inside the aortic lumen. After clear identification and protection of both renal arteries, the large Carrel patch can be fashioned safely.

## Full Multivisceral Organ

En bloc dissection of the liver, stomach, duodenum, intestine, pancreas, and spleen from the diaphragm and retroperitoneum is performed. The graft to be retrieved can be modified according to patient's need with exclusion of the liver or inclusion of the kidney. After dividing the diaphragmatic crura, the abdominal esophagus is stapled. A long segment of thoracic and abdominal aorta is retrieved in continuity with a Carrel patch containing celiac axis and SMA.

## Modified Multivisceral Organ

The procurement of modified multivisceral grafts can be aborted because of arterial anomalies that could potentially compromise the vascular inflow to the isolated liver allograft [19]. For proper cost-effective planning, CT angiogram may be considered at the time of donor evaluation. However, the decision to proceed with retrieval of the liver and the modified multivisceral graft to be given to two different recipients currently takes place in the donor operating room in most cases. In the presence of replaced or accessory right and/or left hepatic artery, the decision is based on liver surgeon's decision whether the accessory hepatic artery can be sacrificed or reconstructed on the back table with a branch of the main hepatic artery. Preoperative CT angiogram or intraoperative ultrasound withclamping of the accessory vessels could facilitate the decision.

Similar to the full multivisceral organ retrieval, en bloc dissection of abdominal organs is carried out followed by transection of abdominal esophagus. The liver graft is separated in situ or on the back table . The hepatic artery is transected at the level of the common hepatic artery and the gastroduodenal artery is also divided. The bile duct is transected 5–10 mm above the duodenum to allow duct-to-duct reconstruction in the recipient who undergoes native pancreaticoduodenectomy. The portal vein is transected 5–10 mm above the splenomesenteric confluence to allow portal vein anastomosis in the recipient [4]. Allograft splenectomy is performed on the back table. Great attention must be directed to avoid injury of the pancreatic tail during allograft splenectomy. Preservation of the donor spleen en bloc with the composite allograft has been advocated by others [9, 24].

### Interposition Vessel Grafts

It is imperative, after completion of visceral organ retrieval, to obtain adequate arterial and venous grafts [6, 20, 21]. An iliac vein is commonly used as an interposition venous graft that is anastomosed to donor SMV for venous drainage. Iliac and carotid arteries are ideal conduit to be placed on the recipient's aorta for implantation of isolated intestinal graft.

With combined liver-intestinal or multivisceral transplantation, a long segment of the thoracic/abdominal aorta is retrieved in continuity with the origin of both celiac axis and SMA. A segment of the back table prepared aortic conduit will be placed on recipient aorta, and the other segment is utilized on the back table as a single arterial conduit anastomosed to the common Carrel patch of both the celiac trunk and SMA.

## Recipient Surgery

### Two-Stage Approach

In preparation for visceral transplantation, a first stage surgical exploration has been increasingly utilized. The primary purpose of the approach is to eradicate intra-abdominal infections by surgical methods including debridgement, repair of fistulae, and restoration of gastrointestinal continuity. Upon referral, these patients often have intra-abdominal infection with enteric leak, abscesses, enterocutaneous fistulas, infected foreign materials including ventral hernia mesh, and venting tube drainage with colonized multidrug-resistant organisms. Because of the need for heavy maintenance immunosuppression after visceral transplant, successful treatment of these infections is necessary for successful outcome.

Another valuable purpose of the initial surgical exploration is to restore gastrointestinal continuity. Foregut and midgut reconstruction, particulary in patients with prior bariatric surgery, reduces the need for composite visceral allograft by salvaging the native stomach and may eliminate the need for isolated intestinal transplantation in selected cases after successful rehabilitative surgery including bowel lengthening.

When such an ambitious goal of achieving natural autonomy is not reached, restoration of upper gastrointestinal continuity temporally improves quality of life and more importantly reduce the number of required visceral organs with the need in most cases for intestine-only allograft (Fig. 39.5). Accordingly, the pancreatic gland from the same donor can be retrieved and utilized for another recipient. Another important advantage of the technique is utilizing the native conduit as an end stoma in patients who require allograft enterectomy due to graft failure.

### Evisceration of Native Organs

Evisceration of the diseased native organs is the initial step of the recipient transplant operation and is primarily determined by the extent of the underlying visceral pathology.

At the time of transplant, with the exception of motility disorders, most recipients have already lost most of the native intestine but may require completion enterectomy. In addition, recipients receiving liver and intestinal transplantation require total hepatectomy. Following dissection of the portal vein, a portocaval shunt is created to decompress the remaining left upper abdominal native organs including stomach, duodenum, pancreas and spleen. With modified or full multivisceral transplantation, the native organs can be removed en bloc or in a piecemeal fashion. The commonly used piecemeal evisceration technique consists of the following steps [19]:

1. Completion enterectomy with surgical excision of residual small intestineand colon if indicated. With modified multivisceral transplantation, preservation of the blood supply to the native liver is crucial with avoidance of injury to any vascular anomalies including replaced right hepatic artery that may arise from the SMA.
2. With multivisceral transplantation, subtotal gastrectomy is performed with transection of the stomach 3–5 cm below the esophagogastric junction. With modified multivisceral transplantation, the left accessory hepatic artery that may originate from left gastric artery should be preserved by careful dissection close to the gastric wall.
3. With the need for native pancreaticoduodenectomy,with and without preservation of the spleen, the pancreaticoduodenal complex is mobilized from the retroperitoneum. The common bile duct and gastroduodenal artery are then dissected and transected. The splenic artery and vein are separately ligated for complete removal of duodenum, pancreas, and spleen. For spleen-preserving pancreaticoduodenectomy (SPPD), the head of the pancreas is transected anterior to the confluence of the portal vein. Subsequently both segments of pancreas are removed with individual ligation of all tributaries of both the splenic artery and vein.

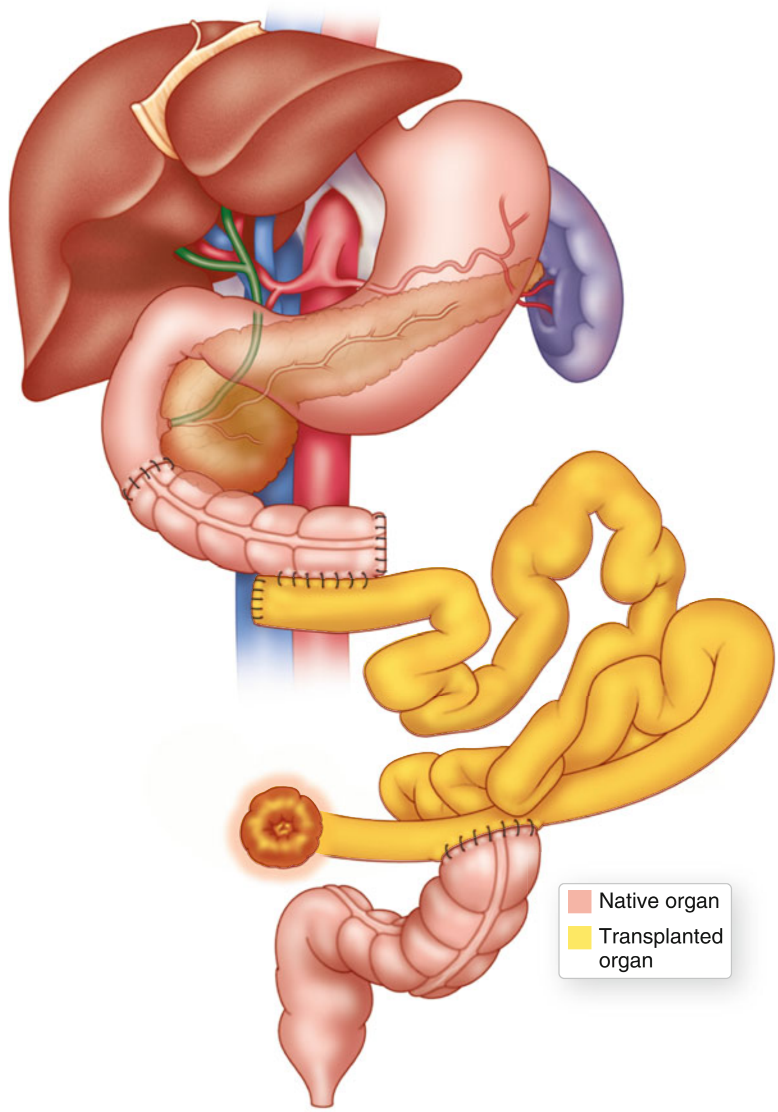



**Fig. 39.5** Colonic interposition and intestinal transplantation. A patient who developed midgut volvulus and underwent total enterectomy with leaking duodenal stump. Upon referral, a duodenocolic anastomosis was performed in close proximity to the duodenal papilla. After recovery, the patient underwent a transplant with an isolated intestine without the need for gastric or duodenum-contained allograft utilizing a segment of the native colon as a visceral conduit between native duodenum and proximal allograft jejunum. The allograft terminal ileum is then anastomosed to the distal end of the remaining native colon

4. With full multivisceral transplantation, hepatectomy is performed in a piggyback technique by ligating and dividing all short hepatic veins. Hepatic artery and portal vein are preserved until the back table procedure is completed to minimize the time of the anhepatic phase.

## Transplantation of the Visceral Graft

### Vascular Reconstruction

#### Interposition Vascular Grafts

The initial in situ placement of a free donor arterial and venous conduit in the recipient before bringing the visceral allograft to the operative field is introduced by the senior author and later utilized by others. The technique avoids having to work in a confined space around the bulky visceral organs. The technique facilitates a safe vascular reconstruction with shorter implantation time of the visceral allograft [6] (Fig. 39.6).

#### Arterial Inflow

With isolate intestine, iliac or carotid arterial graft is placed on the native aorta in an end-to-side fashion. During implantation of the intestine, the arterial graft is anastomosed to the SMA of the intestine.

With composite visceral grafts, the aortic origin of both the celiac and superior mesenteric artery are retrieved en bloc and constructed as a single Carrel patch. The Carrel patch is then anastomosed on the back table to a single arterial conduit utilizing a segment of the donor thoracic aorta. Under certain circumstances, a bifurcated common iliac arterial graft is

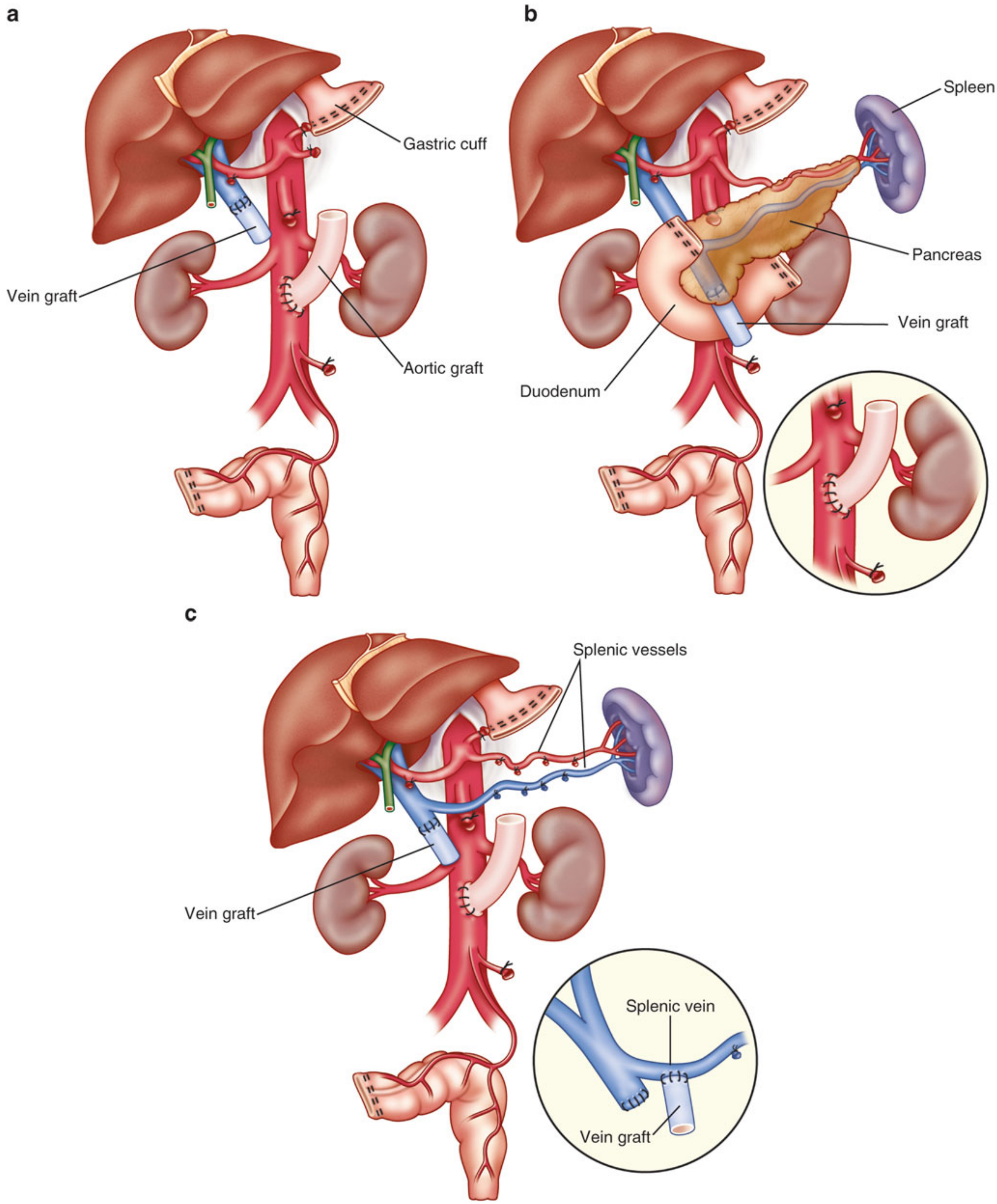



**Fig. 39.6** The recipient operation with complete or partial removal of the native left upper abdominal organs and placement of interposition vascular grafts for modified multivisceral transplantation. (**a**) Major evisceration with near-total gastrectomy, total enterectomy, and pancreaticoduodenectomy. (**b**) Preservation of the splenopancreaticoduodenal complex. (**c**) Pancreaticoduodenectomy with preservation of the native spleen

anastomosed to the splenic and superior mesenteric artery of the visceral graft on the back table for en bloc intestine and pancreas transplant (Fig. 39.7). Before implantation of the visceral organs, another donor aortic conduit is anastomosed to the recipient supraceliac or infrarenal aorta in an end-to-side fashion. Finally the arterial reconstruction is completed by anastomosing the two aortic conduits (Fig. 39.8).

### Venous Outflow

Venous outflow from liver-free visceral grafts such as isolated intestine and modified multivisceral can be established with either portal or systemic drainage. Portal drainage had been considered to be more physiologic than caval drainage, supported by various animal models that showed optimum liver structure and function depending on hormones (especially insulin), nutrients, and other substances from splanchnic venous blood [25]. As a result, diverting the portal flow with its hepatotrophic factors from the liver can cause hepatic atrophy and impaired liver function. Accordingly, it is our practice to attempt portal drainage if technically feasible.

Iliac vein is commonly used as an interposition graft in end-to-end or end-to-side to the recipient portal vein in the hepatic hilum, SMV or splenic vein. For caval drainage, interposition venous graft is placed to the recipient infrarenal vena cava, renal, or iliac veins.

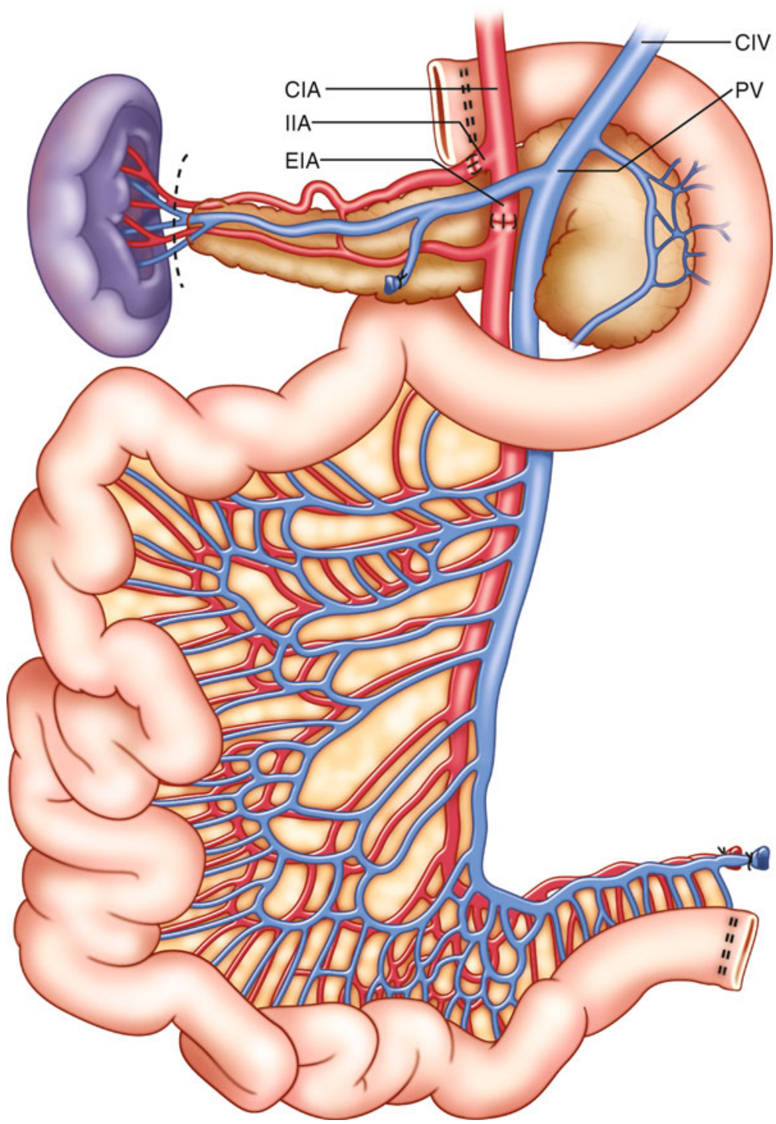



**Fig. 39.7** Back table vascular reconstruction of a composite intestinal-pancreatic allograft with a bifurcated iliac arterial graft and common iliac vein graft. *CIA* common iliac artery, *CIV* common iliac vein, *EIA* external iliac artery, *IIA* internal iliac artery, *PV* portal vein

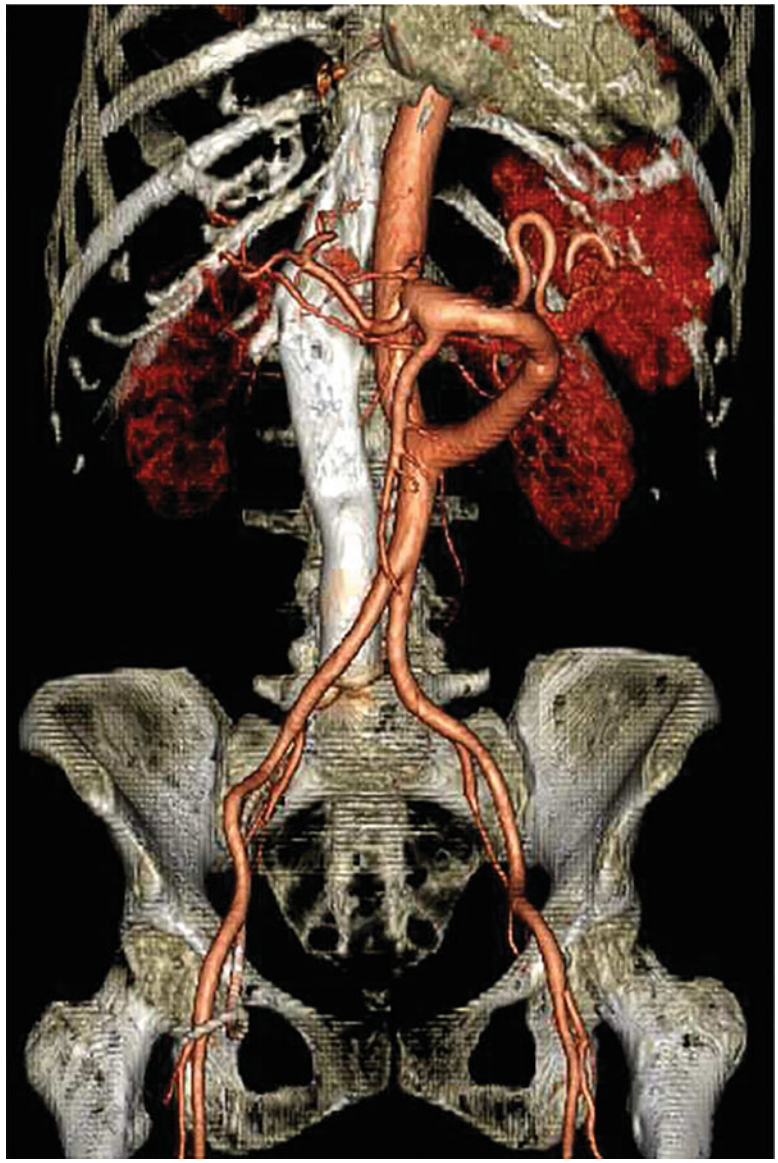


**Fig. 39.8** 3-D computed tomography of an infrarenal aortic graft with a single common conduit of a Carrel patch containing both the celiac artery and SMA

With visceral allograft contained liver, venous outflow is created between recipient and donor vena cava mostly with piggyback technique. With combined liver-intestinal transplantation, a permenant portocaval shunt is performed between the native portal vein and inferior vena cava.

## Restoration of Gastrointestinal Continuity

With isolated intestinal transplantation, the proximal anastomosis is performed between the distal end of residual native intestine and transplanted jejunum. With full or modified multivisceral transplant, the residual recipient gastric cuff or abdominal esophagus is anastomosed to the anterior wall of the donor stomach. Pyloroplasty is performed because of gastric denervation. With liver-intestine transplantation and en bloc preservation of the pancreaticoduodenal complex, the native duodenum or jejunum is anastomosed to the allograft jejunum just distal to the duodenojejunal junction. Reconstruction of the hind gut is established in recipients with residual colorectal segment with creation of chimney ileostomy or simple loop ileostomy. Patients with previous proctocolectomy receive an end ileostomy.

Restoration of gastrointestinal continuity has received various modifications. With modified multivisceral transplantation, the duct-to-duct biliary reconstruction is required for recipients who undergo complete evisceration or spleen-preserving pancreaticoduodenectomy (SPPD). For patients with preserved native duodenopancreatic complex the native and transplanted duodenum are anastomosed in a piggyback fashion [18]. The technique is indicated for patients with pseudo-obstruction syndrome who had end-stage dysmotility

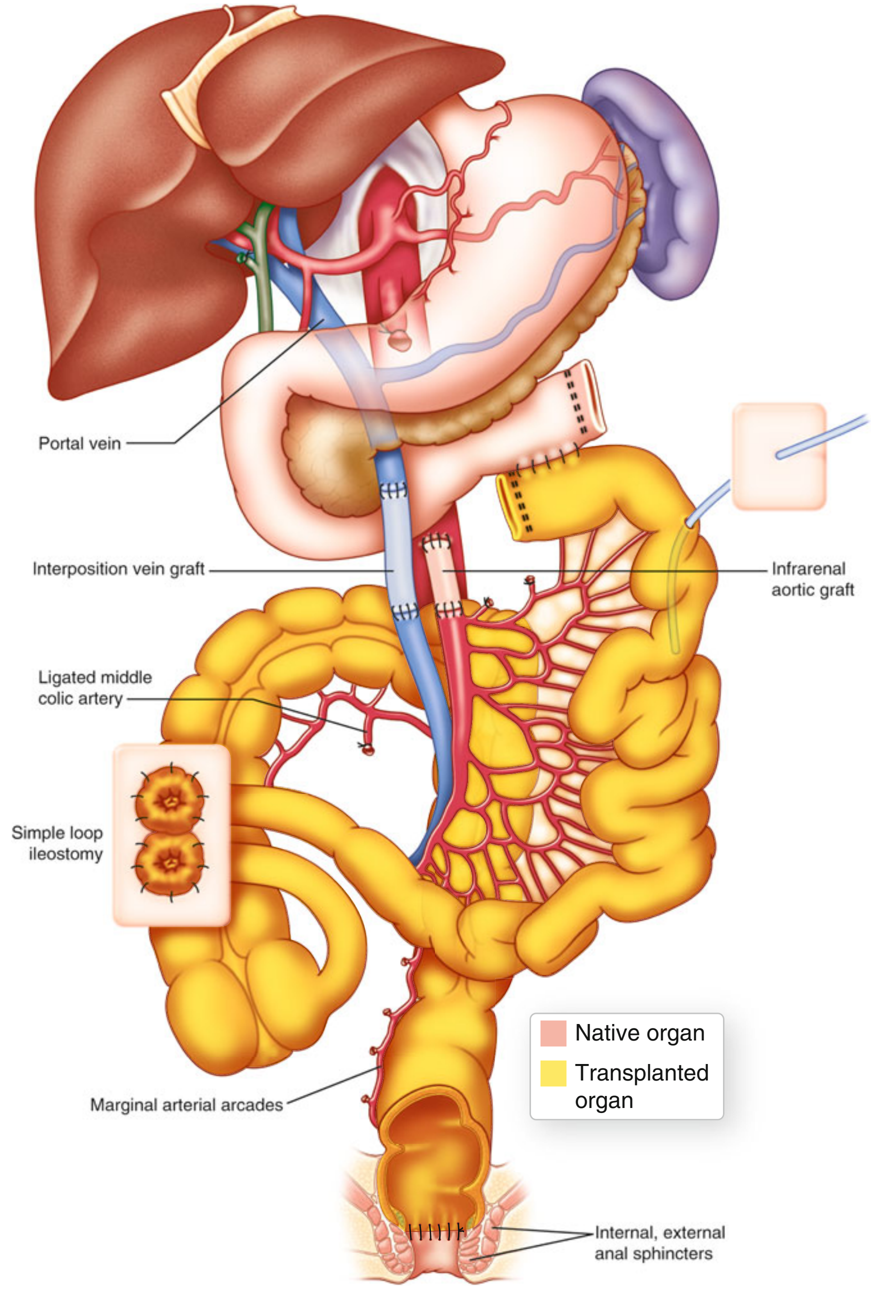



**Fig. 39.9** Hind gut pull-through reconstruction with en bloc colon and intestinal transplantation

of both intestine and stomach. The preserved duodenum is shortened to avoid segmental dysmotility.

An innovative sphincter-preserving pull-through technique was recently introduced by the senior author. The procedure was performed in a Crohn's disease patient with prior total proctocolectomy and preserved anal sphincter utilizing an en bloc colon and small bowel transplantation [26, 27] (Fig. 39.9). The colon is procured en bloc with small intestine with preservation of the middle colic and ligation of the inferior mesenteric artery close to its origin. It is essential to preserve the right colic artery and the colonic marginal arterial arcades to maintain adequate blood supply to the distal end of colonic graft. Twenty four to 48 hours after transplantation, the pull-through operation is completed by transanal dissection of the rectum with preservation of the internal and external anal sphincter. The anastomosis is established between the allograft colon and the recipient anal verge. The technique has the potential to improve allograft absorptive function and quality of life in patients with preserved anal sphincter.

## Abdominal Wall Reconstruction

Abdominal wall closure is one of the most challenging technical problems in visceral transplantation [6, 16, 17, 28]. The extreme difficulty in facing complete closure of the abdominal wall is due to significant loss of the abdominal domain because of previous multiple abdominal surgeries with total enterectomy, coexistence of multiple enterocutaneous fistulae, and abdominal wall resection due to desmoid tumors. The failure to close the abdominal wall results in high mobility and mortality.

Before transplantation, implantation of tissue expander can be helpful to increase the surface area of the abdominal wall skin [15]. At the time of transplantation [15], a proportionally smaller organ donor, graft reduction, skin closure with or without component separation techniques, myocutaneous flap, and fascial closure with mesh or other tissue can be entertained. As a nonvascularized tissue allograft, the use of fascia of the rectus muscle from the same donor is also reported [29].

One of the novel approaches in abdominal wall closure is the simultaneous abdominal wall transplantation [28, 30]. Abdominal wall graft with rectus abdominis muscles is procured with external iliac vessels. Implantation of abdominal wall is initiated after revascularization of the visceral allograft. Blood supply of abdominal wall is derived from the donor epigastric artery that can be anastomosed to recipient epigastric artery using microscope [30] (Fig. 39.10a). Alternatively, donor epigastric vessels are brought to the field in continuity with the external iliac vessels that are implanted into the recipient's common iliac vessels [28] (Fig. 39.10b).

Abdominal wall transplantation is a novel and feasible technique, but has not gained popularity in the community because of its technical complexity and potential postoperative complications. In many high-volume centers, most of the visceral allograft transplants are done without the need for major autologous or allo-abdominal wall reconstruction by the good selection of smaller size donors and judicious intraoperative intravenous fluid resuscitation with simple abdominal wall skin closure [3].

## Therapeutic Advantages of the surgical modifications

The technical modifications have improved the therapeutic efficacy of the different types of visceral transplant. With modified multivisceral transplantation, donor liver is utilized for another recipient with end-stage liver disease. Preservation of the native spleen with pancreaticoduodenal complex improved survival with reduced risk of PTLD [19, 31–33] (Fig. 39.11). Another important advantage of preserving the pancreaticoduodenal complex is to improve the technical feasibility and safety of the procedure and to augment long-term advantages. By preserving the duodenal sweep, biliary drainage is easily established with a piggyback fashion between native duodenum and allograft duodenum or jejunum. As a result, biliary complications were eliminated. In addition, the islet cell mass is increased with reduced risk of calcineurin inhibitor and steroid-induced diabetes. With the adoption of

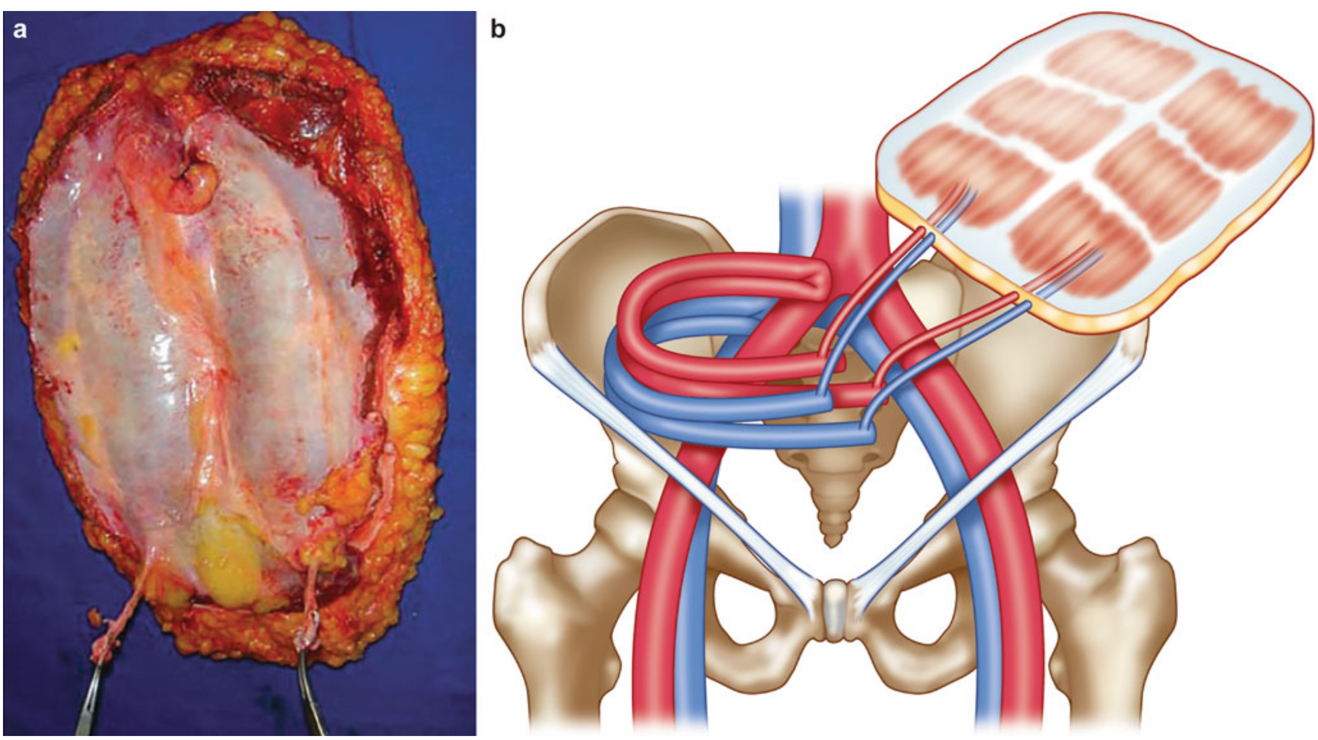



**Fig. 39.10** (**a**) The abdominal wall graft isolated with bilateral epigastric pedicles (reprinted from Cipriani R, Contedini F, Santoli M, et al. Abdominal wall transplantation with microsurgical technique. Am J Transplant 2007:7:1304–7; with permission). (**b**) Donor epigastric vessels retrieved in continuity with the external iliac vessels that are anastomosed into the recipient's common iliac vessels

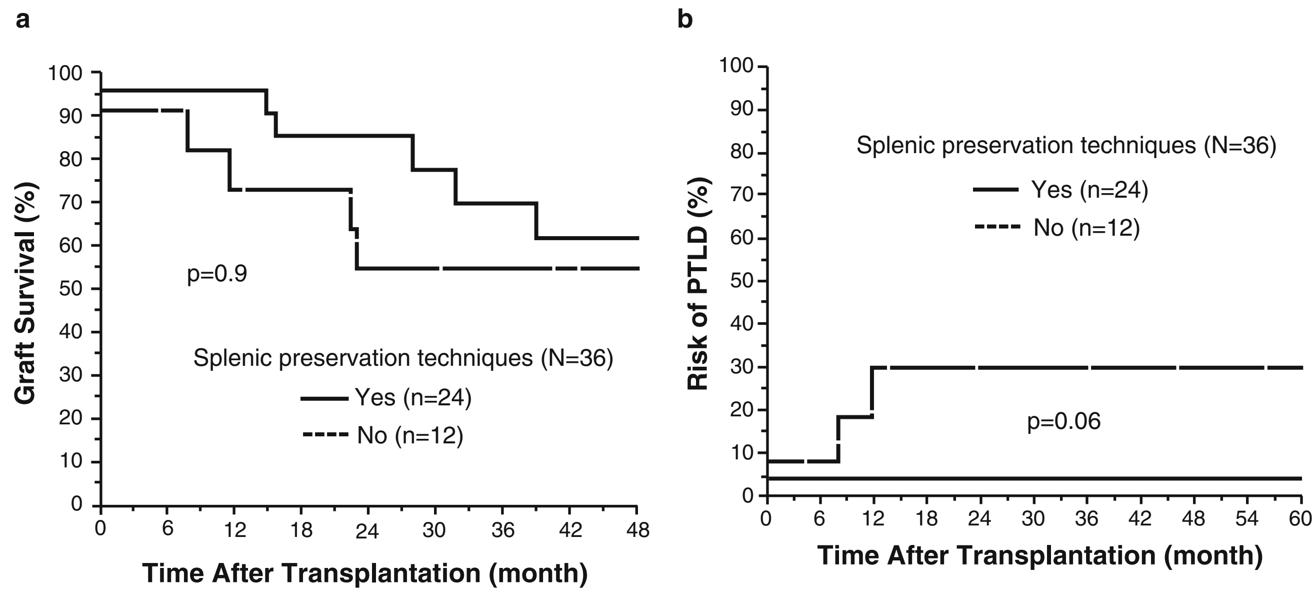
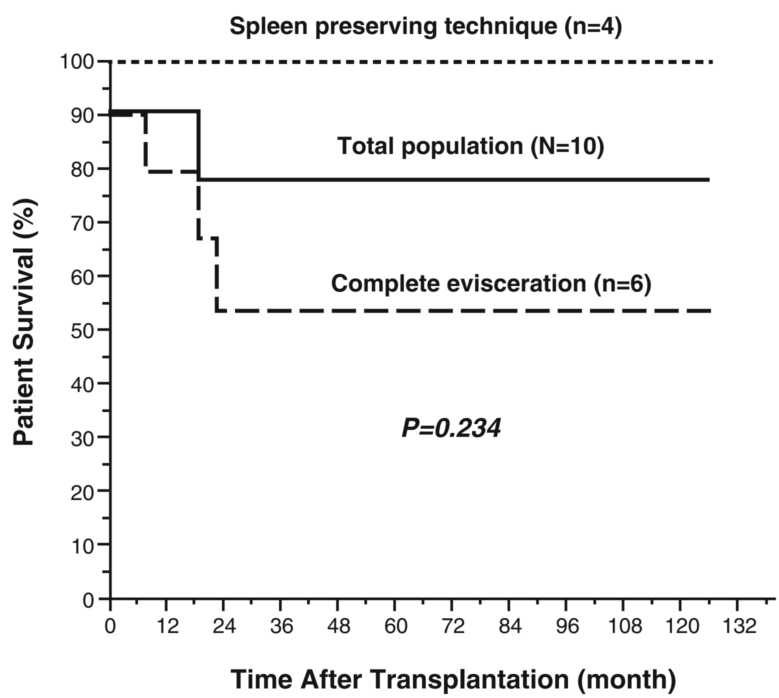



**Fig. 39.11** (**a**) Kaplan–Meier graft survival according to the type of the recipient operation shows better short- and long-term survival in the splenic preserving techniques. (**b**) Cumulative risk of post-transplant lymphoproliferative disorders (PTLD) in patients with and without preservation of the native spleen. Note the lower risk of PTLD with splenic preservation (data from Cruz RJ Jr, Costa G, Bond G, et al. Modified "liver-sparing" multivisceral transplant with preserved native spleen, pancreas, and duodenum: technique and long-term outcome. J Gastrointest Surg 2010;14(11):1709–21)

**Fig. 39.12** Patient survival following modified multivisceral transplantation for Gardner's syndrome patients according to the type of evisceration technique (data from Cruz RJ Jr, Costa G, Bond G, et al. Modified multivisceral transplant with spleen-preserving pancreaticoduodenectomy for patients with familial adenomatous poplyposis "Gardner's syndrome." Transplantation 2011;91(12):1417–23)




portal venous drainage of the liver-free allograft, proper delivery of the hepatotropic factors to the native liver is maintained with different physiologic and immunologic benefits.

For those who required pancreaticoduodenectomy including patients with Gardner's syndrome who have duodenal adenoma(s) with severe dysplasia [18, 34–37], it is our common practice to preserve the native spleen [32, 33] (Fig. 39.6c). The published data demonstrated improved patient survival with reduced risk of PTLD and GVHD (Fig. 39.12). Efforts should always be made to preserve native spleen with all types of visceral transplantation because of its physiologic and immunologic therapeutic advantages.

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