Intestinal and Multivisceral Transplantation: The Operation

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Contents

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Abstract

Intestinal transplant remains the most complex, expensive, and uncommon transplant among all the solid organs. However, given its 1-year survival is now as high as other solid organs, it is no longer considered an experimental procedure. Recent advances in patient and graft survival, in part, are due to the refinement of the surgical techniques. Advances in patient and donor selection and better understanding of immunological and infectious complications have also contributed to improved outcomes. Given intestinal failure is often found in the presence of other organ damage, the intestine is the core of what has most recently been called *visceral transplantation*. A combination of classic and newer techniques of visceral transplantation and its most common variations will be described. This chapter reflects solutions and evolvement in the realm of visceral transplantation based on hundreds of cases over more than 10 years.

Keywords

Intestinal transplant · Visceral transplantation · Multivisceral transplant · Modified multivisceral transplant · Colon transplant · Abdominal wall transplant · Hybrid ostomy · Intestinal failure · Portal mesenteric thrombosis · Short bowel syndrome · Motility disorder

Introduction

Intestinal transplant is no longer an experimental procedure as its 1-year survival is as high as other solid organs. Part of this success is due to refinement of surgical techniques, advances in patient and donor selection, and better understanding of immunological and infectious complications. It is still the most complex, expensive, and uncommon transplant among all the solid organs; due to these reasons, it is only performed in a few centers around the globe.

Intestinal failure is often found in the presence of other organ damage requiring the transplant of multiple viscera. The scope of this chapter is to describe the surgical techniques of visceral transplantation and its most common variations. The intestine is the core of what has most recently been called visceral transplantation. Immunologically, we could divide visceral transplantation into liver-inclusive and liver-exclusive grafts. Although, there is a continuous discussion about nomenclature, for didactic purposes we will describe here the three most common variations of visceral transplantation: isolated intestine (intestine-colon), modified multivisceral, and multivisceral transplantation (Bhamidimarri et al. 2014) (Fig. 1).

Isolated Intestinal Transplant (Intestine-Colon)

Isolated intestinal transplant, or intestine-colon, is a procedure currently indicated when patients develop life-threatening complications of parenteral nutrition. The main indication is short bowel syndrome. Most recent series demonstrates excellent survival; hence, it is becoming the treatment of choice for intestinal failure (Beduschi et al. 2015, 1). This procedure is selected when the liver, pancreatic, and gastric functions are preserved.

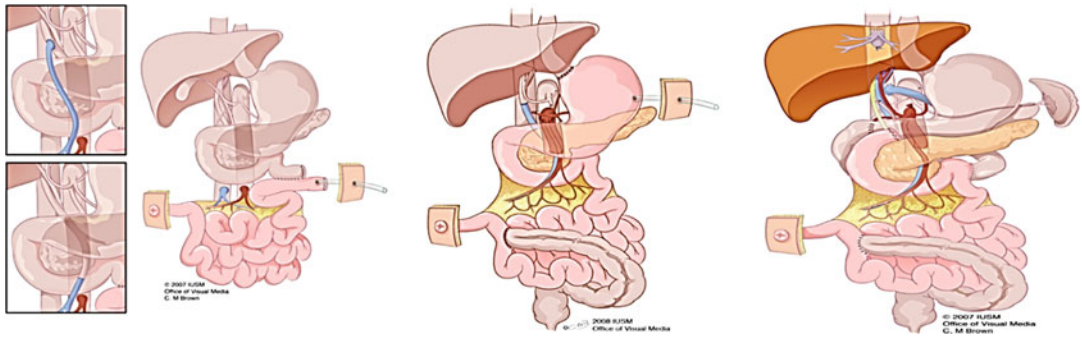

Fig. 1 Main types of visceral transplant: isolated intestine, modified multivisceral, and multivisceral

Fig. 2 (**a**) Dissection of vena cava and aorta, (**b**) Vascular grafts were anastomosed to vena cava and aorta

Surgical Technique

In general, a xyphopubic midline incision with the use of a "Bookwalter" type retractor is the preferred approach. The presence of multiples adhesions, enterocutaneous fistulas, and ostomies are not uncommon, making the dissection sometimes difficult and labored. Special attention and careful dissection are fundamental to avoid injury to the duodenum, bladder, and ureters. They may be very attached to other structures, making a distorted anatomy a common finding.

After the diseased native intestine is removed, it is time to think about the type of vascular reconstruction to be performed. This depends on the native disease, size and quality of the vessels, and surgeon's preference. The mesenteric vessels can be placed in a heterotopic position, to aorta and cava, and in an orthotopic position, to superior mesenteric artery and vein. Basically, if the patient lost the intestine due to vascular disease, a heterotopic reconstruction is the most logical choice. Also, if the patient presents some degree of liver fibrosis, mild portal hypertension, or some congestion of the liver, systemic drainage is a better and safer option for the intestinal graft. For the other indications, orthotopic placement of the vessels is preferred. A combination of both can be done as well.

Heterotopic or Systemic Drainage (Fig. 2a, b)

Infrarenal aorta and vena cava are dissected. In the aorta dissection, the superior limit is the left renal vein. Inferiorly, the level of inferior mesenteric artery or just below should be sufficient. Similar dissection is carried on at the vena cava. The gonadal vein may be ligated if at the level of the anastomosis. Space should be adequate to allow a small *satinsky* clamp to be applied.

Sizeable lymphatics should be divided between ties to avoid chylous ascites. Before the aorta and/or cava clamping, 50–100 U/kg of heparin (maximum 5000 U) is given. The use of extension vascular grafts is preferred to decrease the clamping time of the main vessels, facilitate the operation, and at the same time, to make it safer. Donor iliac vein is usually used as vein graft, and donor carotid artery is thought to be the best match for the superior mesenteric artery. In case it is not available, donor iliac artery can be used. After the anastomosis of the extension grafts, small clamps are applied individually, and the *satinsky* clamps are removed from the aorta and vena cava. At this point, the intestinal graft is brought to the surgical field, and attention is turned to the length of the vessels. If they are too long, there is an increased risk of kinking and further vascular thrombosis. First anastomosis is the arterial, and it is performed in a parachuting fashion. Extra attention should be paid in the venous anastomosis. Correct orientation is fundamental to avoid problems. Very often it is difficult to determine which is left and right in the superior mesenteric vein in the graft. For this reason, it is highly recommended to have both sides marked with a pen or small sutures placed during the donor operation when the graft is being harvested to prevent a mistake. Once right and left is defined, the anastomosis is performed in a standard fashion. When clamps are removed, it is uncommon to have hemodynamic instability or any major bleeding because most of the dissection of the graft is carried on in the warm phase in the donor. Intestinal graft should perfuse quickly, and a beautiful pink color should be observed. Any sign of venous congestion should be promptly evaluated and usually requires repositioning of the graft to correct an outflow obstruction due to torsion of the vein. Vein graft should be very soft to digital compression; if not, a problem in the anastomosis should be ruled out. Careful manipulation of the graft is essential after reperfusion to avoid traction and injury to the anastomoses.

Orthotopic or Portal Drainage (Fig. 3)

The dissection for the orthotopic drainage requires more time, and it is more labored, but it is preferred whenever possible. Dissection of the superior mesenteric vein is performed almost to the level of the confluence to the splenic vein. Usually the first jejunal branches of the vein and the artery can be preserved. Venous branches from the uncinate process of the pancreas may need to be tied to release the vein and to achieve a more anatomical position for the anastomoses. The need for extension vascular grafts is defined by the length of the vessels in the graft, depending mainly if the pancreas was also harvested or not and the position of the vessels. You will not always find the superior mesenteric vein on the right side and superior mesenteric artery immediately on the left. They can have a more vertical position to each other. The use of extension vascular grafts can correct this position allowing a proper angle to the anastomoses. Selection of the extension grafts and the use of heparin were mentioned above and follow the same principle. At this point, the intestinal graft is brought to the field, and anastomoses are performed in a standard fashion. Artery is done first, and vein follows after careful identification of the right and left side. Reperfusion should occur in an uneventful way, and the graft should not present any signs of congestion.

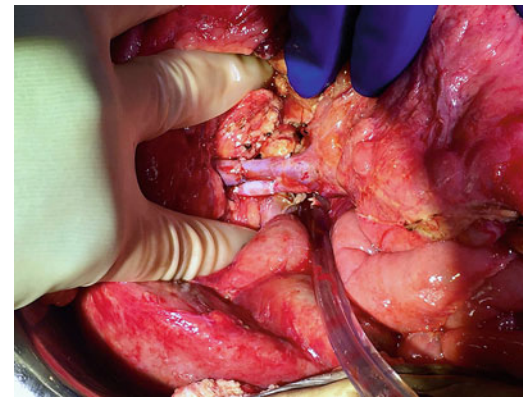

Fig. 3 In this case, extension graft was placed only in the superior mesenteric artery

Proximal Reconstruction and Gastrostomy

A jejunum to jejunum anastomosis is the most common proximal reconstruction. Sometimes,

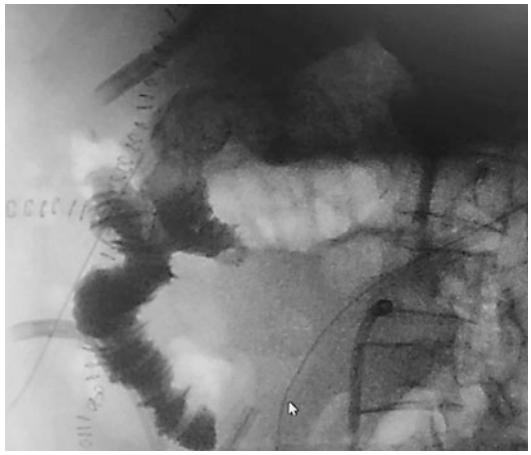

Fig. 4 Duodeno-jejunum anastomose performed in the second portion of duodenum

duodeno-jejunum (Fig. 4) or even gastro-jejunum is required depending of the native anatomy of the recipient. The anastomosis is performed hand sewing, in two layers, 10–15 cm from the Treitz ligament if possible. This extra length will allow placing a jejunostomy in case the graft has to be removed for any circumstance.

Gastrostomies are reserved for the patients with food aversion or previous gastrostomies. Most of the patients leave the operating room with a naso-jejunal tube.

Multivisceral Transplant

Multivisceral transplant includes the transplant of the liver, stomach, pancreas, small bowel, and colon. It is a rare procedure, requiring extra expertise and structure of the hospital. To be a successful surgical team, anesthesia and critical care have to collaborate. It is the most complex operation a human being can have, and for this reason, not only surgical steps will be discussed but also a few anesthetics and perioperative considerations.

Anesthetic Considerations

At least two good central venous accesses should be obtained before starting the operation. Other than central access, good and sizable peripheral veins should be cannulated as well. Two arterial lines, central venous pressure, and transesophageal echocardiogram are part of the hemodynamic monitoring. Usually 20–40 units of pack red blood cells, fresh frozen plasma, and platelets should be placed on hold. If a patient develops coagulopathy after reperfusion, cryoprecipitate may be necessary. Judicial use of pressors during the explant will decrease the need for volume replacement. Decreasing the venous pressure will decrease the blood loss from varices.

Special attention should be given to the massive transfusion of plasma, platelets, and cryoprecipitate directly into the heart with the rapid infuser. These patients are hypercoagulable at baseline, and there is an increased risk of development of cardiac thrombus. An alternative is to transfuse those products separately using the peripheral access or into a femoral line, avoiding direct contact with the valve trabeculae in the heart and intracardiac thrombus formation.

After reperfusion, requirement of volume will increase substantially. Very often, a large amount of fluid shifts to the third space and into the intestine. Most likely this is the effect of the reperfusion syndrome and may last more than 24 h.

Surgical Technique

A xyphopubic midline incision with extension to the right should be performed. Sometimes, due to the size of the spleen, an extension to the left (cruciate incision) may be necessary. Huge varices may be noted in the skin, and major bleeding with mortality even before entering the abdominal cavity has been described.

Exenteration

After inspection of the cavity and control of the varices in the abdominal wall, the dissection starts mobilizing the right colon and small intestine from the retroperitoneum. Many collaterals will be found in this normally "avascular plan." Combination of electrocautery, ties, and bipolar vessel sealing device is used to dissect and achieve hemostasis. Once the intestine is mobilized and

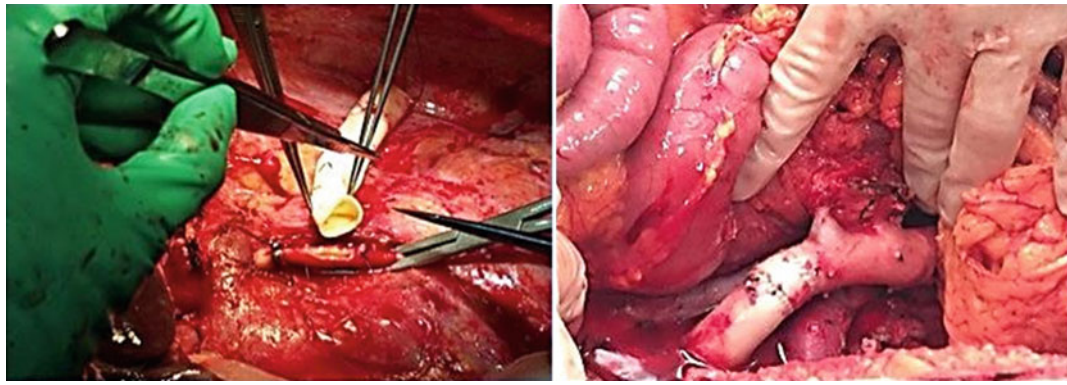

Fig. 5 Aorta clamped and jump graft being anastomosed. Aortic graft after reperfusion

retroperitoneum is exposed up to left renal vein, a right and transverse colectomy is performed, dividing the colon at the level of the splenic flexure. The next step is to remove the small bowel. Jejunum is divided with linear stapler just after the ligament of Treitz, and straight vascular clamps are placed in the mesentery. After the entire intestine is removed, the mesentery is oversewn.

At this point, anatomy and previous surgeries will define the best strategy. If possible, the pancreas is encircled, clamped, and divided at the level of the body. This approach exposes the celiac trunk and the superior mesenteric artery, which are subsequently tied. Subsequently, the spleen and the pancreas should be mobilized from the retroperitoneum in a plain above the left adrenal gland. Kocher maneuver is performed. Short gastric vessels should be divided from the spleen, and using linear stapler, the stomach is divided preserving a cuff for the future anastomosis. The spleen and the tail of the pancreas are removed. The liver hilum is divided between clamps as well, and piggyback technique is performed. The liver, head of the pancreas, and duodenum are removed.

The infrarenal aorta is fully exposed and dissected, and a vessels' loop is placed around the inferior mesenteric artery. The aorta is clamped, and the artery is incised with a number 11 blade. An opening is created using an aortic punch. Anastomosis between a short segment of thoracic aorta from the donor and the infrarenal aorta is performed using running prolene sutures (Fig. 4). The aortic conduit is clamped, and the clamp from the aorta is released. The anesthesia team should be informed prior to the removal of the aortic clamp because usually a drop of more than 40 mmHg points in the systolic pressure may be temporally observed.

Embolization of the celiac artery and superior mesenteric artery immediately before the transplant may facilitate the exenteration of native organs, decreasing the blood loss and requirement of transfusions as described by Pirene's group recently (Ceulemans et al. 2015).

Implant

A common opening among the hepatic veins is created. The multivisceral graft is brought to the table, and an anastomosis between the superior vena cava of the graft and the hepatic veins of the recipient is performed in a running fashion with prolene sutures. Graft is irrigated with 3 L of a solution with albumin 10% in room temperature or flushed with blood before releasing the venous clamp. Anastomosis between the aortic conduit and the aorta of the donor is performed in a running fashion (Fig. 5). At this point, graft is ready to be reperfused. Total anhepatic phase is usually less than 1 h.

Reperfusion is the most critical part of this operation, and the entire team should be ready for adverse events. Blood pressure should be preferably above 120 mmHg of systolic. Potassium must be low. Syringes with sodium bicarbonate, calcium, insulin, magnesium, and vasoactive drugs must be ready to be used in case needed. Liters of warm

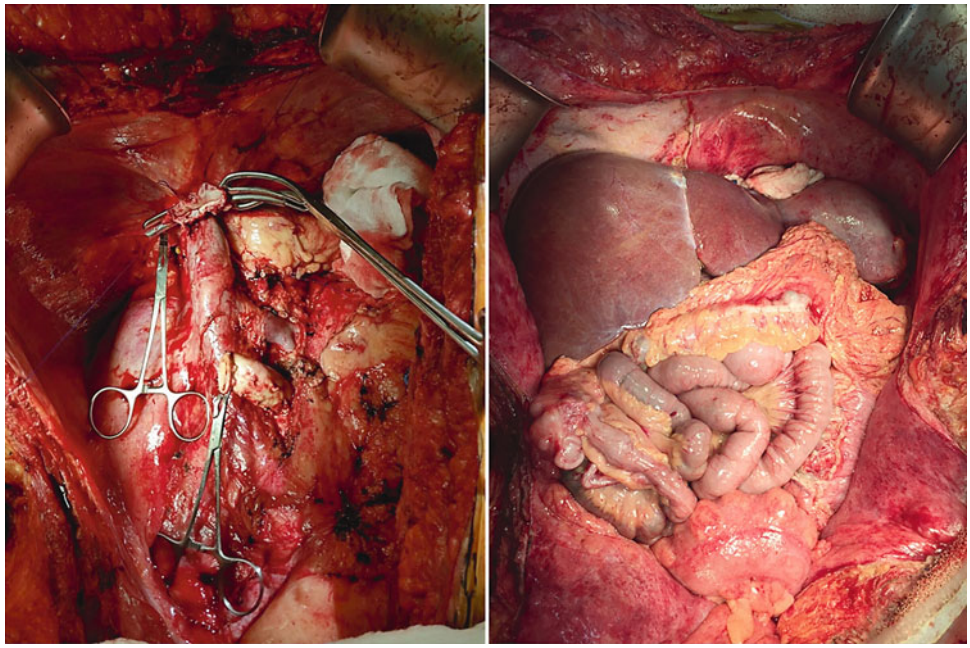

Fig. 6 Abdominal cavity empty with the aortic graft in place and then after reperfusion

irrigation must be available. Patient's heart will receive a load of potassium from the cold preservation solution. After the clamps are removed, patient will behave as if they are losing blood. Blood, cold and full of potassium from the preservation solution, has to fill the entire multivisceral graft before returning to the heart. Arrhythmias and hemodynamic instability are not uncommon. Major problems will be seen in the first 10 min after reperfusion. Coagulopathy after reperfusion is common and should be corrected with a combination of platelets, plasma, and cryoprecipitate. Further transfusions will be based on the thromboelastogram findings (Fig. 6).

After hemostasis is accomplished, a gastric-gastric anastomosis is performed in two layers. Once the posterior wall is finished, a nasogastric tube and a naso-enteric tube are placed, and the anterior layer is completed. A Nissen fundoplication is the final step of the upper anastomosis (Fig. 7). Gastric tube is rarely performed. Pyloroplasty is routinely done. A colon-colon anastomosis is the final step of the operation and should be done preferentially end-to-end or end-to-side fashion**.** Side to side seems to be safer, although it makes the colonoscopies technically very challenging**.** Ostomies are no longer performed in patients with preserved native colon in some centers due to the low incidence of rejection in multivisceral patients (Beduschi et al. 2015, 2). All the spaces in the mesentery between the anastomosis should be closed to prevent volvulus. Primary closure of the fascia is achieved in most of the patients with splanchnic thrombosis, but there is need for biological mesh in most of the short bowel patients.

Sometimes patients can develop severe coagulopathy, and the surgery may not be finished at one time. Packing with lap sponges and closing the skin only is an alternative to stabilize the patient in the critical care unit. In these cases, the colonic anastomosis and final closure are performed in 24 or 48 h or as soon patient becomes hemodynamically stable.

Postoperative Period

The initial post operator period of a multivisceral transplant patient may be very challenging.

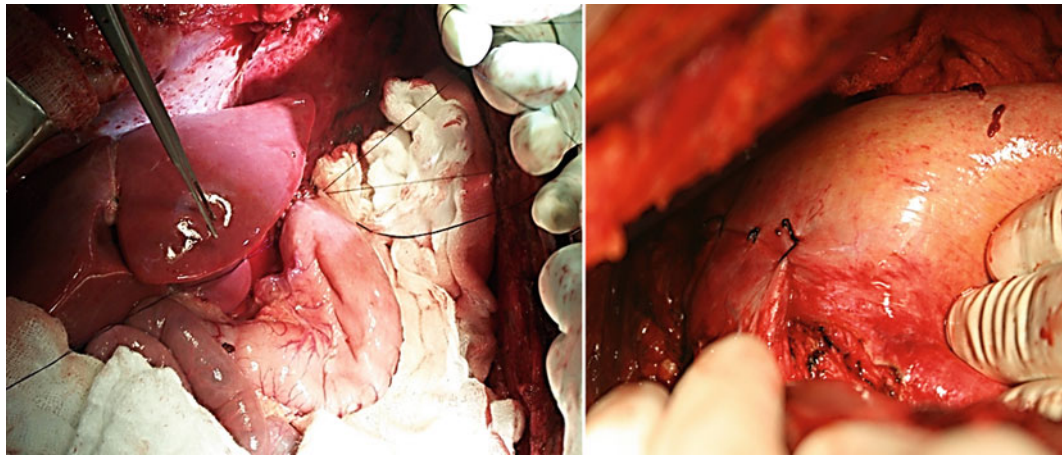

Fig. 7 Gastric-gastric anastomose and Nissen fundoplication

Surgical trauma is enormous. Massive transfusions in the operating room are not uncommon. Sometimes substantial blood transfusions continue in the ICU. Large amount of fluids are required in the first 24–48 h. Nasogastric tube is kept for 7–10 days, then diet is started, and parenteral nutritional weaned off as oral intake improves. Induction with anti-lymphocyte preparations is almost universal among centers, and maintenance varies around the use of tacrolimus and a second agent. Steroids are usually discontinued a few months after transplant. Lower endoscopies are performed according to the center's preference. If no ostomy is placed, as is the new norm in some centers, the first scope is performed after 3 weeks and/or if symptoms of rejection occur. Follow-up with citrulline, immunoglobulin levels, chimerism, and donor-specific antibodies is performed for all the patients routinely.

Multivisceral Backup Concept

One of indications for multivisceral transplantation is end-stage liver disease with diffuse portomesenteric thrombosis. For patients with very extensive thrombosis, a liver transplant may not be possible, and a multivisceral transplant is the ultimate option. Once all the minimally invasive options to reestablish adequate portal flow are exhausted, a multivisceral transplant is considered. For some patients with Grade 4 thrombosis though, a liver transplant still may be performed (Vianna et al. 2012). Triple phase CT scan is carefully evaluated. In patients with multiple abdominal surgeries (hostile abdomens), or if there is a possibility to restore the portal flow utilizing low dissection of the main portal vein combined with thromboendovenectomy or a venous jump graft to a mesenteric branch, the patient is listed for a multivisceral backup. In this way, a multivisceral graft is available in the operating room during the transplant. Patients listed for a multivisceral backup should be anticoagulated to avoid worsening of the thrombosis.

The concept is simple. The candidate is listed for a regular multivisceral transplant (stomach, pancreas, liver, small bowel, and colon). Once a donor becomes available, the organs are harvested "en block" with standard techniques. Dissection in the recipient starts a little earlier than usual and differs from a standard multivisceral.

The initial dissection is very similar to a liver transplant. After mobilization of the liver, attention is turned to the hilum. Careful dissection of the hepatic artery is performed. The artery is dissected and individualized from the adjacent tissues but should not be tied at this point. Bile duct is identified and divided between sutures. Portal vein should be carefully skeletonized. Hepatic artery should be very mobile at this point,

especially after the ligation of the gastroduodenal artery. A vein retractor should medially retract the hepatic artery giving full access to the portal vein. After the transection of the portal vein, a meticulous low dissection of the portal vein combined with thromboendovenectomy is performed. Dissection of the branches of the superior mesenteric vein in the mesenteric root can also be attempted. Collaterals or the inferior mesenteric vein are also viable options. All these techniques have been described elsewhere.

Preserving the hepatic artery during the dissection of the portal vein avoids prolonged and unnecessary anhepatic phase leading to early coagulopathy and metabolic acidosis. After careful evaluation of all the possible alternatives to restore portal flow, decision is made to proceed with a liver alone or to switch to a multivisceral transplant. The rationale for using this approach is to offer all the possibilities to the candidate and also to be able to perform low dissection and thromboendovenectomy in an aggressive way and still be able to rescue the situation if uncontrollable bleeding occurs or if no flow is achieved utilizing the portomesenteric system.

If the decision is to proceed with a liver only, the organs are separated in the backbench, and the pancreas is transplanted in another recipient. The pancreas is allocated in advance as backup for another recipient. Logistically, it works better if the backup patient is in the same center or in a near center in order to minimize ischemic times.

Modified Multivisceral Transplant

Modified multivisceral transplant includes the transplant of the stomach, pancreas, small bowel, and colon. By far, the most common indication is pandysmotility of the gastrointestinal tract with preserved liver function. It is a technically demanding operation with unique features.

Explant

Resection of the stomach, pancreas, small bowel, and most of colon is performed. Careful dissection is performed in the hilum of the liver. The liver needs to be preserved, and special attention to prevent injury to its structures is fundamental. Hepatic artery is identified and dissected down to the celiac trunk. Splenic artery will be tied. Gastroduodenal artery should be tied and divided. Main bile duct should be encircled and divided close to the pancreas. When all the organs are dissected and ready to be explanted, the stomach is transected; superior mesenteric artery is divided, and the portal vein should be divided as long as possible. The liver will remain perfused exclusively through the hepatic artery until the reperfusion of the new organs. Special and more laborious dissection occurs when patient presents with a hepatic artery from the superior mesenteric artery (Fig. 8).

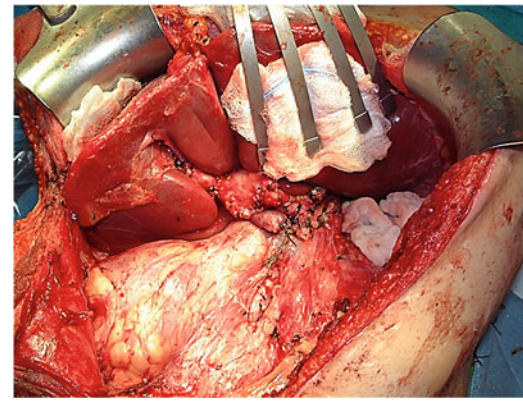

Fig. 8 Modified multivisceral recipient after the explant

Implant

Organs are brought to the field, and anastomosis of the portal vein is performed. End-to-end anastomosis is performed in a standard fashion with extra attention to avoid traction when the arterial reconstruction is done. Anastomosis of the aorta, stomach, pyloroplasty, and + – ostomy follows the same description as the multivisceral transplant. Reconstruction of the bile duct is performed in the standard way as done in a regular liver transplant. Roux-en-Y can be done as well.

Ostomy, No Ostomy, and Hybrid Ostomy

Historically, an ostomy was mandatory in intestinal transplant, and frequent endoscopies for mucosal evaluation were routine. For some patients, this is still the safest approach and commonly used among all transplant centers.

Biopsy and histologic evaluation is the gold standard for graft assessment in intestinal transplantation. Usually, a temporary ostomy is created to facilitate graft evaluation. Ostomy biopsies can be performed without sedation in most cases, and the risk of complication is minimal. However, ostomies are often associated with episodes of dehydration leading to readmissions, low patient satisfaction, and social limitations. In some patients, intestinal and multivisceral transplants can be selectively performed without an ostomy (Beduschi et al. 2015, #3). Nevertheless, patients need sedation for colonoscopies, a not well tolerated colon preparation, and the graft cannot be evaluated early in the postoperative period due to increased risk of perforation. Potential delays in the diagnosis of rejection may be another risk of not performing an ostomy. For all these reasons, the need for an ostomy is customized based on the age, anatomical and surgical features, type of graft, and overall immunological risk.

Multivisceral transplants have a lower chance of rejection, and it has become customary not to perform an ostomy for these recipients (Beduschi et al. 2015, #2). Ostomies are only performed in special situations for multiviscerals recipients. A pediatric recipient weighing less than 10 kg requires an ostomy because it is very difficult to reach the terminal ileum through a regular colonoscopy. Patients with motility disorders and abnormal anorectal manometry require an ostomy in order not to compromise the entire graft given potential obstruction at the anastomosis. Another situation where an ostomy may be used in the multivisceral transplants is patients with no rectum or very short stump where the distal reconstruction is high risk for leaks. In these cases a loop ileostomy will protect the anastomosis.

Isolated intestines and modified multiviscerals recipients have increased immunological risk and require frequent graft evaluation. An ileostomy or colostomy is performed in a loop fashion or using the "Chimney or Bishop-Koop" technique. Some patients require a definitive ostomy, usually colostomy.

Of late, the concept of hybrid ostomy has been developed (Beduschi et al. 2015, #3). This technique combines the benefits of easy graft evaluation via a regular ostomy without the hurdles of having one. The hybrid ostomy is disconnected from the GI tract, keeping the vascular pedicle intact. That way, the patient has an ostomy without stool output. This hybrid ostomy technique was first described using the transplanted colon. It is well-known that the terminal ileum is the first part of the graft to present any pathological finding. It is not uncommon to simultaneously have normal transplanted colon and rejection in the terminal ileum biopsy. To maximize the graft evaluation, the original hybrid ostomy technique using the transplanted colon was abandoned and redesigned utilizing the terminal ileum. After reperfusion, proximal and distal anastomoses are performed in the standard way. Terminal ileum is divided 15 cm from the ileocecal valve using GIA stapler. Another GIA stapler is fired 15 cm proximally from the initial division. The mesentery is divided up to the base making sure vascular supply is preserved. Excluded 15 cm of the ileum is moved medially, and a side-to-side anastomosis in two layers is performed in the standard way between the two sides of the ileum. Defect in the mesentery is closed to prevent internal hernias. Ostomy is brought out to the skin and matured in standard fashion (Fig. 9). Hybrid ostomy combines all the benefits of not having a real ostomy with the advantage of histological evaluation of the graft without the risks and preparation of a colonoscopy. It is technically easy; patient satisfaction is high, and episodes of dehydration are rare. Ostomy takedown does not affect the intestinal function, and hospitalization is not required. Hybrid ostomy has become a standard procedure in some centers.

Colon Transplant, Pull Through, and Use of the Entire Colon

Colon is normally transplanted in all types of intestinal grafts. In a survey during the Congress of the Intestinal Transplant Association in 2017, all the major transplant centers include the colon as part of the transplant. Colon inclusion translates to less diarrhea, less episodes of dehydration, and overall higher patient satisfaction and quality of life. Usually, in the donor operation, the colon is divided at the level of the splenic flexure, respecting the superior mesenteric irrigation.

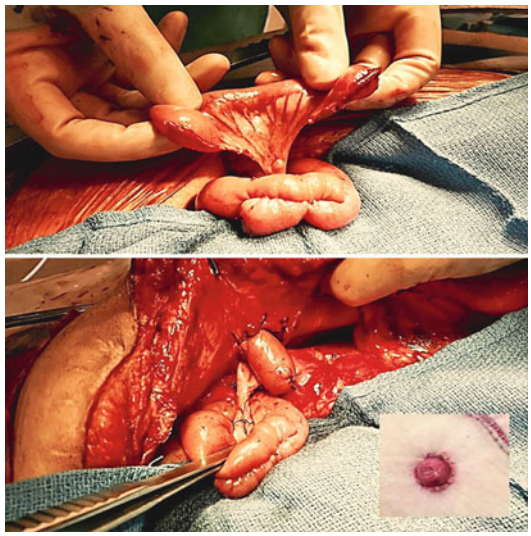

Fig. 9 Hybrid ostomy. Preserved vascular pedicle but not connected to the GI tract

In patients with motility disorders such as Hirschsprung's disease, or with previous resection of the rectum, the ability to restore the intestinal continuity is limited; hence, an end ostomy is the most common choice. A small intestinal pull-through is a common procedure used in pediatric surgery but very rarely used for transplant patients. More recently, pull-through operations to reconstruct this population using the transplanted colon have been performed (Beduschi et al. 2017) (Fig. 10). The reconstruction can be performed days after the transplant or even after years. A loop ileostomy is done to protect the colon-anal anastomosis and early graft surveillance.

Sometimes the colonic graft may not be long enough to reach the pelvis when it's divided at the splenic flexure. In that case, transplant of the entire colon, including descending and sigmoid,

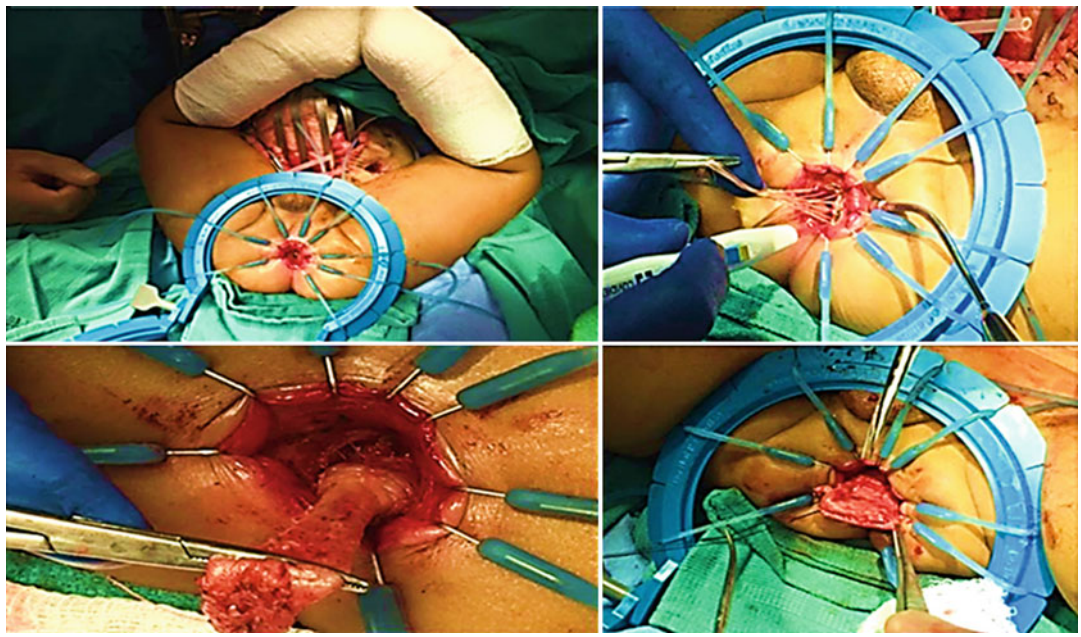

Fig. 10 Pull-through operation 3 days after a multivisceral transplant in a pediatric patient with Hirschsprung's disease

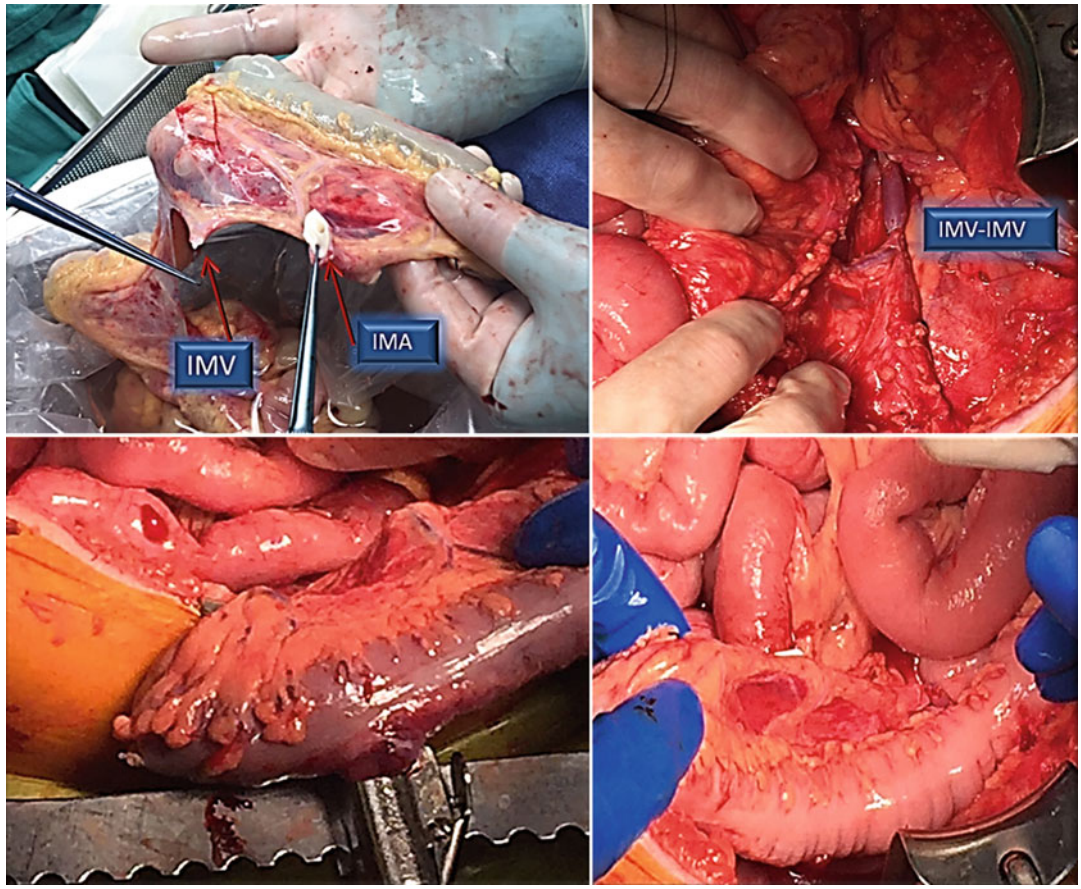

Fig. 11 Transplant of the entire colon. On the bottom, after the reperfusion of the main graft and then after the reperfusion of the inferior mesenteric vessels. Note how the sigmoid becomes pink

is possible. For multivisceral grafts, it is important to preserve the inferior mesenteric vein, and only the reconstruction of the inferior mesenteric artery may be needed. In case of the isolated intestinal/colon grafts, the reconstruction of inferior mesenteric vein and artery is necessary. Reconstruction may be performed orthotopically in the inferior mesenteric vessels or heterotopically in the vena cava and aorta (Beduschi et al. 2017) (Fig. 11).

An important technical detail about colon transplant is the middle colic vein. It is not a problem for the multivisceral grafts, because the organs are "en bloc" and torsion of the superior mesenteric vein does not happen. However, it is critical for the isolated intestine (intestine-colon) grafts. After reperfusion and when the distal reconstruction will be performed, extra care should be taken to avoid torsion of the colic vein when rotating the colon. It can happen more commonly with systemic drainage than with portal drainage. After colonic reconstruction is performed, it is important to check the orientation of the superior mesenteric vein and look for signs of graft venous congestion. Torsion of the vein is a catasthrophic complication leading to graft loss if not immediatelly identified.

Colonic anastomosis can be performed in different ways: side to side, end to side, and end to end, usually in two layers hand sewing and without the use of stapler devices. It is important to keep in mind, mainly for the patients without an ostomy, the angle and position of the colon that will facilitate a colonoscopy in the future, making access to the terminal ileum easier.

Closure

Abdominal cavity, or lack thereof, is a common problem in intestinal transplantation. Patients lose the abdominal domain due to multiple resections. It is often difficult to find organs that will fit without closure problems. Multiple techniques have been described to achieve complete closure of the abdomen after transplant (Mangus et al. 2012). The use of biological mesh (*alloderm*) is preferred to close the fascia in the majority of patients when primary closure is not possible (Selvaggi et al. 2009). It is easy to manipulate, and it does not have to be removed in the presence of infection (Fig. 12). In extreme and rare cases, abdominal wall transplant can be performed (Gondolesi et al. 2009) (Fig. 13).

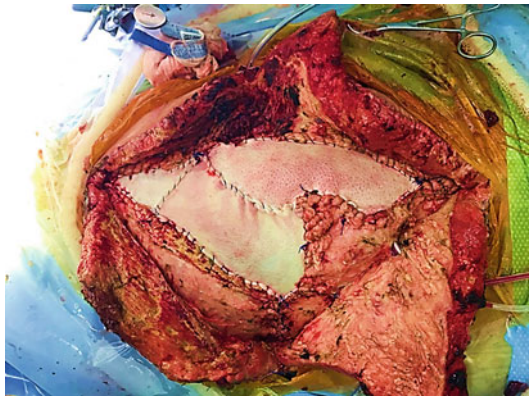

Fig. 12 Huge abdominal defect closed with alloderm mesh. Skin is closed after raising skin flaps

Conclusion

Visceral transplantation is still a rare and very specialized procedure. Recent advances in patient and graft survival, in part, are due to the refinement of the surgical techniques described here. Surgical complications still exist, but they are no longer the Achilles heels of these operations. This chapter describes a combination of classic and

Fig. 13 Abdominal wall transplant combined with intestine-colon transplant

newer techniques and reflects solutions and evolvement based on hundreds of cases over more than 10 years.

Cross-References

► Donor Selection and Operation

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