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BRIEF REPORT

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Cadaveric small bowel/split liver transplantation in a child

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Abstract Scarcity of size-matched grafts continues to be a major limiting factor for liver and combined liver/intestinal transplants in the pediatric population. It is reported that 29 % of pediatric patients listed for hepatic transplantation die while waiting for a donor. The reported mortality of pediatric patients awaiting intestinal transplantation is about 40 %. We report on a technique of segmental liver and intestinal transplantation in a child. To our knowledge, this is the first report of a combined split liver-intestinal transplantation. We used a cadaveric donor, but the technique can also be performed with a live donor. The adult recipient of one segment of the liver was discharged home without complications. The child who received the combined liver intestinal graft developed intestinal perforation and severe rejection and died. If this technique is applied successfully, the adverse effects and mortality of a long pretransplant waiting period in pediatric patients may be avoided.

Key words Split liver transplantation, pediatric · Small bowel transplantation, pediatric

Introduction

Tacrolimus has significantly improved short and long-term survival after intestinal transplantation. The latter is now a practical, and at times the only remaining, option for patients with intestinal failure who are suffering, serious complications of their disease or for those receiving parenteral nutrition. One major limitation of intestinal transplantation is the shortage of size-matched grafts, particularly for infants and children, and this accepted results in considerable morbidity and mortality. Living related intestinal transplantation has been proposed as a potential solution to the problem. We report a technique of segmental liver and intestinal transplantation in a child. In this case the transplant was unsuccessful because of a combination of technical and immunological complications. Out donor was cadaveric, but the technique can also be performed with a living related donor.

Case report

The recipient was a 7-month-old boy with microvillous inclusion disease. He was being maintained on parenteral nutrition and was referred to our institution for evaluation. His course was complicated by progressive jaundice, due to micronodular cirrhosis, and by marked cholestasis as well as depleted access for parenteral nutrition. He was referred to us for combined intestinal and liver transplantation. The donor was a 16-year-old boy weighing 60 kg, with the same blood type as the recipient (A,Rh+), who had died of a gunshot wound to the head. The intra-abdominal organs, including the distal esophagus, stomach, duodenum, pancreas, liver, small intestine, and large intestine to the sigmoid colon, were procured en bloc after the ends were transected with a stapler. The aorta was divided between the renal arteries and the superior mesenteric artery (SMA) distally and in the chest proximally. The donor's hepatic artery was found to originate from the SMA. The liver was separated from the other abdominal organs. The SMA was transected just below the pancreas and the portal vein at the junction of the SMV and portal vein. The pancreas, colon and the proximal part of the intestine were removed, leaving the ileum to be used as the intestinal graft. The liver was divided on the back table as well. Transection of the hilar structures took

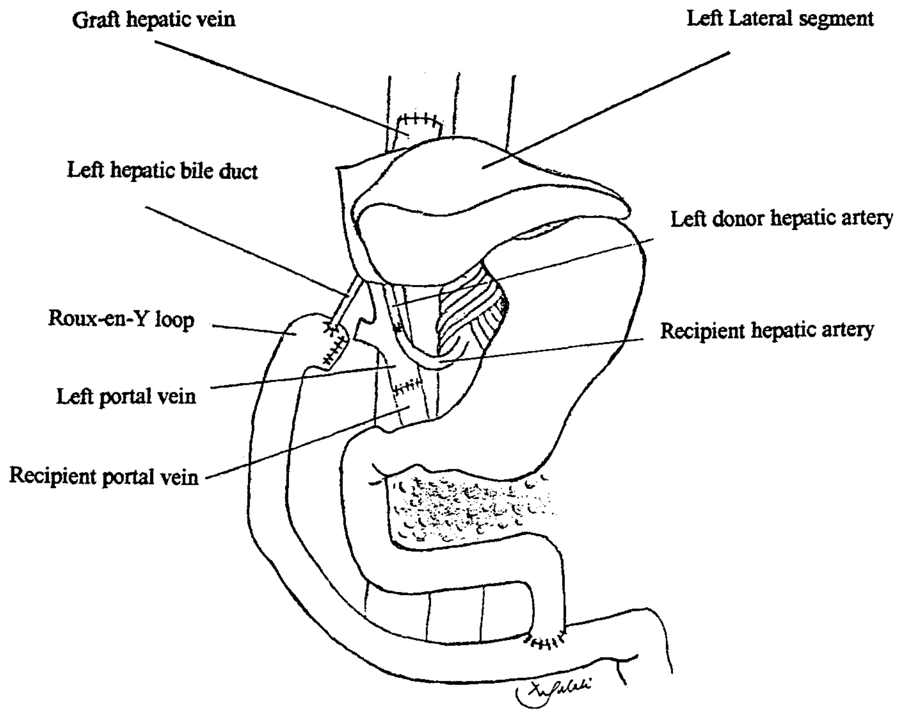

Fig. 1 Vascular and biliary anastomoses of the left lobe of the donor liver

place at the level of the umbilical ligament. As a consequence, the SMA, the common bile duct, the extrahepatic portal vein, and the inferior vena cava were left in continuity with the right part of the graft. Segment 1 was resected. The left hepatic artery, left hepatic bile duct, and left portal vein were identified on the left part and prepared for anastomosis. There were two left hepatic veins – the main left hepatic and a major tributary – that drained from the left lateral segment to the middle hepatic vein. The latter was identified and prepared for anastomosis. The right lobe was transplanted into an adult patient who had an uneventful postoperative course and was discharged 8 days after the procedure.

The recipient liver was removed, and its three hepatic veins were maintained to create an outflow for the major left hepatic vein of the graft. The left lateral segment of the donor liver was brought to the field and two venous anastomoses were performed, one to the orifice of the three major hepatic veins and the other onto the side of the retrohepatic vena cava. Subsequently, the portal vein anastomosis was performed end-to-end. The liver was then perfused and started producing bile. The arterial anastomosis was performed end-to-end between the left hepatic artery of the donor and the common hepatic artery of the recipient using an operative microscope (Fig. 1). The intestinal graft was then brought into the field. Approximately 130 cm of ileum was transplanted. The distal donor SMA was anastomosed end-to-side to the recipient aorta. The donor superior mesenteric vein (SMV) was anastomosed end-to-side at the confluence of the recipient splenic vein and the SMV (Fig. 2). Perfusion of the intestinal graft and appearance of peristalsis after unclamping was slow, although pulses were visible throughout the graft. The bile duct was anastomosed to a Roux-en-Y loop of donor intestine. The length of the Roux-en-Y loop was approximately 25 cm. The distal end of the ileum of the donor was anastomosed to the side of the native sigmoid colon. The end of the latter was exteriorized. Because of edema, the abdominal wall was closed temporarily with a gortex sheet that was sutured circumferentially to the fascia.

The immunosuppressive regimen consisted of tacrolimus, mycophenolate mofetil, and steroids. The dosage of tacrolimus was adjusted daily in order to maintain 12-h trough levels of 15–20 ng/ml. Parenteral nutrition was given. On postoperative day 4 the patient returned to the operating room. A feeding jejunostomy was placed, the gortex sheet was removed, and the abdomen closed. Enteral feedings were started on the 3rd postoperative day. Sixteen days after the transplantation, the patient developed signs and symptoms of abdominal sepsis and was explored. He was found to have an intestinal perforation at the tip of the feeding jejunostomy tube. The perforation was repaired, and the abdomen was irrigated and closed. An intestinal biopsy performed at this time revealed severe acute rejection; this was treated with a steroid taper and OKT-3. Unfortunately, the rejection was not controlled and on subsequent endoscopy and biopsy, the intestinal mucosa appeared denuded with intense inflammatory infiltrates of the bowel wall, cryptitis, and vascular rejection. There was complete loss of the mucosa with no remaining epithelial elements. The patient's condition was further complicated by bacterial and fungal sepsis and he died 36 days post-transplantation.

Discussion

The majority of children suffering from intestinal diseases become transplant candidates during infancy or early childhood. A shortage of size-matched grafts continues to be a major limiting factor for intestinal or combined liver/intestinal transplants. The reported mortality of pediatric patients awaiting intestinal transplantation is about 40 %; the condition of other patients deteriorates because of the long waiting period [1]. Data

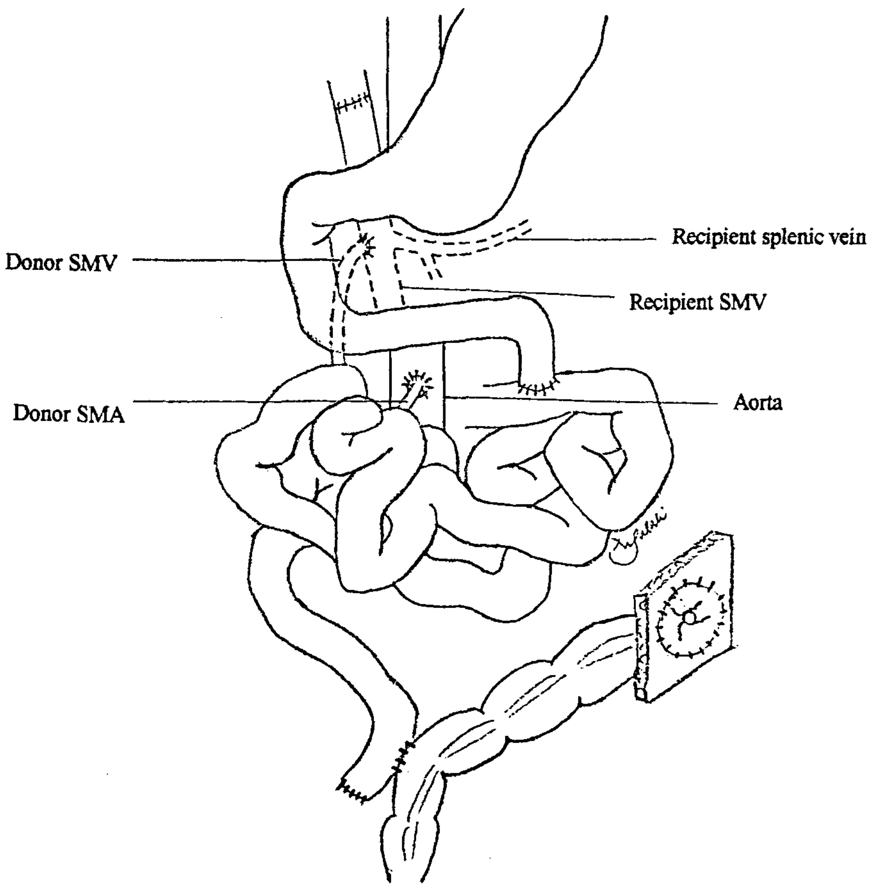

Fig. 2 Vascular and enteric anastomoses of the segmental intestinal graft

available from reduced or split liver pediatric transplants indicate that the use of these techniques results in a shorter waiting period and a reduction in the death rate of patients on the waiting list. Ryckman et al. [12] reported that, in their experience, 29 % of pediatric patients listed for hepatic transplantation died while waiting for a donor. However, with the use of segmental liver transplantation, no child died while waiting for a donor to become available. In addition, the outcomes after transplantation of either a full-size hepatic graft or a reduced-size graft were similar in terms of patient survival, graft loss, and surgical complication rate [2, 5, 9, 16, 18].

The procedure described here demonstrates that it is technically feasible to use donors with size incongruity for combined liver and intestinal transplantation. The two complications that caused our patient's death were not related to the size discrepancy or the division of the organs. The adult recipient of the right liver segment recovered without complications. A potentially serious complication due to size discrepancy is the inability to close the abdomen at the end of the procedure. Yet, this problem is often seen even when there is no size discrepancy. It is frequently due to the lack of abdominal cavity and scarring, as well as to edema of the abdominal organs from third space fluid. Temporary closure with plastic sheets has been a very effective means, as it was in this case.

There is debate in the literature regarding the use of ileal versus jejunal intestinal grafts. Although lymphoid tissue is more abundant in the ileum, in experimental models ileal grafts are not rejected faster than jejunal grafts [16]. Similarly, there is no difference between the jejunum and the ileum with regard to energy metabolism during cold preservation or after reperfusion [10]. Distal segmental grafts seem to be superior in terms of morphologic adaptation [11] and improvement in nutritional parameters [8, 14, 19]. In our patient, the use of the distal ileum was dictated by the discrepancy in size between the donor and the recipient. However, it may be beneficial to use a segmental graft. Although whole grafts are histologically rejected as rapidly as segmental grafts, the toxic effect of a larger graft that is rejected may be more detrimental to the host, as Stangl et al. suggest in their report [16]. In their experimental model of rat intestinal transplantation, larger grafts undergoing rejection led to earlier death of the recipient. On the other hand, a sufficient length of transplanted intestine is necessary for nutritional support. In pediatric patients in particular, the size of the intestinal graft is often partially dictated by the size of the abdominal cavity of the recipient. Moreover, if a whole intestine or jejunal graft is used, it can be reimplanted in continuity with the liver, but it may be easier technically to transplant the two organs separately. Separating the two organs at the back table results in increased cold ischemia time, which adversely affects intestinal motility [7]. This factor could be responsible for the initial absence of peristaltic waves of the graft in our patient. Also, it might be easier to drain the SMV of the donor to the IVC of the recipient [6]. It is not clear whether this has an adverse effect on the host. The absence of portal blood flow to the liver is accompanied by the appearance of apoptotic cells in the acute phase, and of atrophy and nodular hyperplasia in the chronic phase [13, 15]. There is no reduction in bacterial translocation with portal versus systemic drainage [4], although there might be an immunologic benefit associated with the former [21].

Post-transplant gastrointestinal perforation of the native intestine in pediatric liver transplant recipients has been described as occurring wiht a frequency of 30% [20]. Multiple previous laparotomies are a predisposing factor. The transplanted intestine is obviously susceptible to wall necrosis and perforation because of the intense inflammatory infiltrates that accompany rejection. Rejection remains the most significant obstacle for successful intestinal transplantation. Intestinal rejection leads to loss of mucosal integrity, bacterial translocation through the bowel wall, full-thickness intestinal inflammation, and necrosis of the graft. Heavy immunosuppression may be beneficial in the preservation of an intact mucosal barrier but contributes to systemic susceptibility to infection. The use of tacrolimus has made intestinal transplantation feasible, but strategies are required that will enhance the clinical application of the procedure [3, 17].

To conclude, the operation we describe is technically feasible as either a cadaveric or living related procedure. The use of segmental liver and intestinal grafts can ameliorate the graft shortage in pediatric patients, reduce time on the waiting list and, thus, improve post-transplant outcome.

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