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Small Bowel and Colon Transplantation in Rats Using Porto-Portal Cuff Anastomosis

F.H.F. Galvão, R.M.N. Santos, A. Bakonyi Neto, M.A.C. Machado, T. Bacchella, and M.C.C. Machado

ABSTRACT

Portal versus systemic venous drainage and colon grafting are major controversies in the techniques of intestinal transplantation. The rat is the best animal for research in this field. Nevertheless, this model requires complex microvascular anastomoses that are responsible for the high incidence of technical failures. A cuff technique is an easier anastomosis method than a hand-suture. We describe a simplified rat model of small bowel and colon transplantation using a porto-portal cuff anastomosis.

Donor. The entire small bowel, cecum, and ascending colon are harvested on a vascular pedicle, consisting of a long aortomesenteric conduit and portal vein. The right colonic vessels are preserved. The graft is flushed and a cuff device is placed on the end of the portal vein.

Recipient. The graft is implanted through an end-to-side aorto-aorta hand-sewn anastomosis. A segment between the first and second jejunal branch is isolated between clamps to insert into the portal cuff. After reperfusion, the recipient's mesentery is divided just below the cuff anastomosis. The recipient jejunum, ileum, and ascending colon are removed en bloc, and the graft is anastomosed in continuity with the remaining naive intestine concluding the operation. This simplified technique surmounts the technical obstacles in rats because it is easily and quickly performed, maintaining the physiological portal drainage, preserving graft ileocecal valve and ascending colon, and reaching acceptable success after a short period of training.

THE RAT is an optimal animal for intestinal transplantation research; nevertheless, this model requires complex microvascular anastomoses that impair satisfactory success rates.[1–6] A cuff technique for microvascular anastomosis is easier and safer than a hand-suture technique.[2] There is a lack of simplified models to study intestinal transplantation with portal drainage. We describe a simplified model for intestinal transplantation with portal drainage using a cuff technique.

MATERIALS AND METHODS

This study was approved by the ethics committee with animals treated according to institutional norms for laboratory animal care.

Donor Operation

The donor, anesthetized with isoflurane, undergoes a laparotomy using a midline incision. The duodenal vessels are exposed and the mesocolon is carefully separated from the pancreas and epiploics, preserving the right colonic vessels. The middle colic vessels are divided, and the middle and descending colon are separated from the small bowel and ascending colon. The superior mesenteric vein is separated from the mesoduodenum and pancreas. Splenic and pyloric veins are divided, and portal vein dissection continues up to hepatic hilum. The celiac trunk, right renal artery, and lumbar branches are divided. The dissected aorta is clamped below the diaphragm, tied below the mesenteric artery, and cut underneath the clamp and below the tie, performing a long aortomesenteric conduit. The portal vein is cut near the hepatic hilum. The entire small bowel, cecum, and ascending colon are removed, washed, and stored in cold preservation solution at 4°C. A 4-mm length polyethylene catheter with an inner diameter of 1.5 mm is used to make the cuff as described previously[2] with some modifications. Briefly, the vein is introduced into the cuff and everted, covering the outer wall of the cuff. Three equidistant stitches are used to fix the distal part of the everted vein to the base of the cuff.

From Transplantation and Liver Surgery Discipline, University of Sao Paulo, Sao Paulo, Brazil.

Address reprint requests to Dr. Flavio Galvao, Av. Dr. Arnaldo 455, Transplante e Cirurgia do Fígado 3º andar sala 11, Sao Paulo-SP, Brazil- 01246-903. E-mail: fgalvao@usp.br

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Recipient Operation

After midline laparotomy, the thin connective tissue between the duodenum and the colon is divided, exposing the superior mesenteric vein and right colonic vessels. The superior mesenteric vein is dissected between the first and second jejunal branch to insert the donor portal cuff. Eventually the second jejunal branch and the right colonic vein are divided to obtain a wider segment of mesenteric vein. The infrarenal aorta is cross-clamped, and an aortotomy is performed between the clamps. The graft is placed in the recipient's abdomen, and a continuous 10-0 nylon hand-suture anastomosis is performed. The segment of mesenteric vein previously dissected is isolated between clamps, and a venotomy is performed to insert the cuff. A 6-0 tie is used to fix the cuff in recipient's mesenteric vein. The clamps are released, and immediate pulsation of the aortic-mesentery segment and graft reperfusion should be observed. The recipient mesentery is tied below the portal cuff anastomosis and removed en bloc with the native jejunum, ileum, cecum, and ascending colon. Graft jejunum and ascending colon are anastomosed in continuity with recipient jejunum and ascending colon, respectively, to reestablish the digestive tract.

DISCUSSION

There are two major controversies regarding intestinal transplantation techniques: portal versus systemic graft drainage and inclusion of the colon in the small bowel graft.[1,7,8] Current rat models use isolated small bowel grafts,[1–6] consequently, they are inadequate to investigate the role of the ileocecal valve and colon grafting. They require end-to-side microvascular hand-suture anastomosis between donor mesenteric-aorta conduit and portal vein to recipient infra-renal aorta and vena cava, respectively.[1–5] Models using portal graft drainage describe a challenging end-to-side anastomosis between donor and recipient portal vein.[6] Complications in this microvascular anastomosis are frequent, correlating with a high incidence of technical failures.[2–6] The present model simplifies the technique in rats, having the following advantages: (1) Reconstitutes the natural, physiologic portal graft drainage; (2) Simplifies the recipient operation because the portal cuff anastomosis is performed within few minutes without bleeding or venous thrombus; (3) Reduces recipient visceral ischemia period because it eliminates the need for portal vein obstruction used in standard portal drainage technique; (4) Avoids recipient hemodynamic instability because there is no block in the recipient inferior vena cava; (5) Preserves graft extrinsic innervation located around the origin of the superior mesenteric artery and celiac trunk, which preserves physiologic bowel movements; (6) Permits studies of graft ileocecal valve and ascending colon; (7) Is an attractive model to study bacterial translocation because it maintains donor colon; (8) Total procedure can be performed within two hours, achieving excellent success rates; (9) Training period for this procedure (8 ± 3 weeks) is shorter than for classic models (8 ± 5.8 months).[2]

This simplified model offers many possibilities for research because it preserves the graft ileocecal valve, maintains physiological portal graft drainage, reduces operative time, and reaches an acceptable success rate with a short period of training.

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