Experimental Training Model of Pancreas Transplant

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ABSTRACT

Pancreas transplant (Ptx) is the gold standard for the treatment of type I diabetes, mainly when associated with renal failure. The number of Ptx is increasing worldwide, but in developing countries, such as Brazil, the number of centers is small and transplant surgeons need to practice the technique.

Methods. For this model, 21 pancreas harvestings were performed in patient corpses after death from extra-abdominal causes, without pancreatic disease and peritoneal or systemic infection. The vessels of the grafts were prepared on the backtable according to the usual practice in humans. The pancreas was implanted in the inferior vena cava and aorta of mixed breed dogs, with 10 exocrine-bladder drainage and 11 duodenum-ileal anastomosis.

Results. There were anastomotic strictures of the portal vein in dogs 1 and 2. There was no arterial stricture or large bleeding. None of the animals died until the revascularization of the graft. Dogs 2, 5, and 8 died during the exocrine anastomosis. The arterial flow was initially high, but at the end of the procedure there were thromboses of small arteries.

Conclusion. The experimental surgical technique model is feasible, repeating the stages of clinical pancreatic transplantation and allowing the training of surgeons.

DIABETES MELLITUS is the most common endocrinopathy affecting modern humans, reaching around 6% of the economically active population.[1] Kelly and Lillehei performed the first pancreas transplant (Ptx) in 1996 at the University of Minnesota in the US as did Dubernard in Europe in 1978.[2] Ptx became an alternative for the replacement of pancreatic islets of insulin-dependent diabetic patients.[3] Until 1980 the International Registry of Pancreas Transplant registered 12% survival of grafts and 67% of transplanted patients within 1 year, according to the International Pancreas Transplant Registry 2004. From 1966 to 2003, approximately 19,610 Ptx were performed in the world, including 14,306 of them in the US (IPTR, 2004). In developing countries, the number of Ptxs was smaller than the demand of patients. Our goal was to create an experimental model that enable one to repeat all steps of pancreas transplantation to provide surgeons with appropriate training.

METHODS

Twenty-one pancreas transplantations were performed from July 2001 to December 2002. For these models, we used corpses of patients who had died from extra-abdominal causes, without pancreatic disease and peritoneal or systemic infection. For recipients we used mongrel dogs weighing 12 to 15 kg. The animal experiments were in accordance with Law no. 6638 dated May 08, 1978 and the ethical principles of the Brazilian College of Animal Experiment. The anesthesia was in accordance with the Unidade de Tecnica Cirurgica e Experimental protocol, as accepted by the research and medical ethics committees of our medical school and hospital. The approximate cost of the procedure was calculated in detail.

Graft Retrieval Steps

A sternal thoracotomy and laparotomy was performed on the corpse. We checked whether there was any peritoneal or thoracic infections. We dissected the splenic artery (AS) near the celiac trunk. The cecum and ascending colon were dissected with broad exposure of the retroperitonium. The superior mesenteric artery (SMA) dissection, was from above the vena cava and aorta to just above the renal veins. We sectioned the splenocolic ligament and

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0041-1345/06/$–see front matter
doi:10.1016/j.transproceed.2006.06.056

dissected the spleen and pancreas from the retroperitonium. The superior mesenteric vein dissection included a duodenum dissection with section using a linear stapler in the first portion. Dissection of the duodenum-jejunum angle was followed by section with a linear stapler at the third portion. The portal vein and biliary duct dissection included ligation and section of the bile duct. The portal vein was sectioned 1.5 cm above the pancreas. The AS was sectioned near the celiac trunk. The SMA dissection was performed close to its emergence from aorta. The mesenteric vessel under the head and body of pancreas were tied and the graft retrieved including pancreas, spleen and duodenal portions. We dissected and retrieved the common iliac artery (CIA) as well as internal (IIA) and external (EIA) iliac arteries from one side. We preserved the graft in saline solution in a plastic bag with a box of chopped ice.

Table Surgery Steps

We dissected the portal vein, AS, and SMA. We measured the iliac artery and branches so that it was neither too long nor too short. AS and IIA anastomosis were performed with continuous sutures of 6-0, prolene ending at two opposite points. SMA and EIA anastomoses were done with the same technique. CIA catheterization with a number eight Levine catheter and saline solution injection were used to test the integrity and lumen of the anastomosis. The mesenteric arteries and branches tied when injection of saline solution showed holes. The graft is covered with a wet towel with saline solution in the container.

Graft Insertion Steps

The celiotomy and opening of the abdominal wall with dissection of retroperitoneal vessels occurs next. The aorta and vena cava are dissected from the renal veins to the iliac vessel bifurcation. The infrarenal vena cava is isolated with cotton ties, proximally near renal veins and distally near the iliac vein bifurcation. Vascular isolation of vena cava is achieved with a large Satinsky clamp before a 10-mm incision on the anterior wall of the vein. This incision is addressed with Prolene 6-0 sutures placed in the angles of both sides. A terminolateral anastomosis of the graft portal vein to the vena cava is performed with a continuous suture using Prolene 6-0. The infrarenal aorta repair is addressed with cotton ties, proximally near the renal arteries and distally near the iliac artery bifurcation. After vascular dissection of the aorta and control with a large vascular clamp, a 10-mm incision is placed on the anterior wall of the aorta. This incision is addressed with Prolene 6-0 in the angles of both sides. A terminolateral anastomosis is constructed of the common iliac artery graft to the aorta using a continuous Prolene 6-0 suture.

The aorta is unclamped keeping a "bulldog" clamp on the common iliac graft to test the arterial anastomosis. The arterial and venous clamps are released and bleeding from the pancreatic parenchyma controlled. A duodenum-bladder or duodenum-ileal latero-lateral anastomosis is performed in two layers with cotton suture using a cylindrical needle.

Final Assessment

The arterial and venous anastomosis are reassessed to check bleeding and visualize the arterial pulsation.

RESULTS

There was a anastomotic stricture of the portal vein in dogs 1 and 2. There was no arterial stricture nor large bleeding; none of the animals died upon revascularization. Dogs 2, 5, and 8 died due to exocrine leaks. In some dogs, the arterial flow was initially high, but the vessels thrombosed at the end of the procedure.

DISCUSSION

An analysis of the current situation showed that the number of transplantation centers has increased, but transplants are still concentrated in a few sites. Of the 147 kidney transplantation centers and 18 pancreas/kidney centers in Brazil, the southeastern and southern region have 102 and 17, respectively (Brazilian Transplant Registry 2004).

The first stage of harvesting of the organ from a human corpse is identical to a clinical transplant from an anatomical point of view. In this model, we did not perform catheterization of the aorta and the inferior mesenteric vein to infuse the preservation solution. Since these maneuvers are common to all the harvestings, the surgeon can practice them on routine liver and renal transplantation. The back-table is performed as in the clinical setting.[4] In the first two procedures, there were strictures of the venous anastomosis. We solved this problem by excising 2 mm of the anterior wall of the inferior vena cava, as already used with the aortic anastomosis to the common iliac artery. We realized that due to the loss of the microcirculation (graft of corpse without preservation solution),[5] the flow in the vein was low because it had to be only the flow of the inferior vena cava. The arterial flow, initially high for the same reason, thrombosed the common iliac artery in the first hours after revascularization.

We chose a porto-caval anastomosis and arterial graft to the aorta because the anatomic position and the diameter were similar to common iliac artery and external iliac vein of humans used in the clinical procedure, thus affording excellent training. The classic anatomy books do not show the average diameter of these vessels. However, upon ultrasonography[6] and tomography,[7] studies and human autopsies,[8] the measurements of the diameters of the iliac vessels have shown identical values to the ones obtained for dogs, an average of 0.9 cm for the vein and 0.7 cm for the aorta.

This model had a relatively low cost when compared with the high cost of training residents and fellows.[9] The sutures represented approximately 50% of the total cost. The surgeon usually performs the anastomosis with the same suture that will be used in the clinical procedure.[10]

In conclusion, the experimental surgical technique shown in this study was feasible, mimicking the stages in the clinical pancreatic transplantation and allowing adequate training of experienced surgeons to perform this procedure in clinical practice.

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