ORIGINAL ARTICLE

Cold-stored cadaveric venous allograft for superior mesenteric/portal vein reconstruction during pancreatic surgery

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Abstract

Background: SMV/PV resection has become common practice in pancreatic surgery. The aim of this study was to evaluate the technical feasibility and surgical outcome of using cold-stored cadaveric venous allografts (AG) for superior mesenteric vein (SMV) and portal vein (PV) reconstruction during pancreatectomy.

Methods: Patients who underwent pancreatic resection with concomitant vascular resection and reconstruction with AG between January 2006 and December 2014 were identified from our institutional prospective database. Medical records and pre- and postoperative CT-images were reviewed.

Results: Forty-five patients underwent SMV/PV reconstruction with AG interposition (n = 37) or AG patch (n = 8). The median operative time and blood loss were 488 min (IQR: 450–551) and 900 ml (IQR: 600-2000), respectively. Major morbidity (Clavien $\geq$ III) occurred in 16 patients. Four patients were reoperated (thrombosis n = 2, graft kinking/low flow n = 2) and in-hospital mortality occurred in two patients. On last available CT scan, 3 patients had thrombosis, all of whom also had local recurrence. Estimated cumulative patency rate (reduction in SMV/PV luminal diameter <70% and no thrombosis) at 12 months was 52%.

Conclusion: Cold-stored cadaveric venous AG for SMV/PV reconstruction during pancreatic surgery is safe and associated with acceptable long-term patency.

Received 1 February 2016; accepted 21 May 2016

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Introduction

Venous resection during pancreatic surgery is often used to ensure radical removal of pancreatic and distal bile duct cancers and has become common practice.[1] Surgery with venous resection for pancreatic cancers has been proven comparable to surgery without venous resection in terms of perioperative outcome and long-term survival.[2,3] However, the optimal method for venous reconstruction has not yet been established, and several different approaches are reported. Primary end-to-end anastomosis and venorrhaphy are reportedly used in 20–83% and 15–56% of patients, respectively.[4–12] When primary anastomosis is difficult to achieve due to tension and the ensuing risk of stenosis, different types of grafts can be used. Autologous grafts from the internal jugular vein, saphenous vein, superficial femoral vein, left renal vein or gonadal vein have been reported, either as patch or interposition grafts.[13–18] The use of synthetic grafts, such as polytetrafluoroethylene (PTFE) grafts,[19] has been described, and reconstruction with grafts made from bovine pericardium and parietal peritoneum,[20,21] or cryopreserved arterial homografts has also been reported.[22] The use of cadaveric vein allografts (AG) for reconstruction during pancreatoduodenectomy (PD) has been described specifically in only two small series, while this technique has been included with small patient numbers in other reports.[20,23–25] Here, we report, to the

The authors have received no funding for research or publication. This article is not based on previous communication to a society or meeting.

best of our knowledge, the largest series of SMV/PV reconstruction with cold-stored cadaveric vein AG in patients undergoing pancreatic resection. The aim of the study was to assess the technical feasibility of using cold-stored cadaveric venous AG for SMV/PV reconstruction during pancreatectomy and to evaluate long-term patency at the reconstruction site.

Methods

We performed a retrospective review of all patients undergoing pancreatic surgery with vascular resection and reconstruction with AG at our hospital between January 2006 and December 2014. This study was approved as a quality assurance study by the hospital Data Protection Officer at our institution. Where applicable, the study was reported in compliance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[26] Hospital records and pathology reports were reviewed. Preoperative workup included multidetector computed tomography (CT) with an optimized pancreatic protocol and a chest CT. Preoperative imaging was evaluated for tumor-vein circumferential interface (TVI) as described by Tran Cao *et al.*,[27] and for the length of tumor-vein involvement (LTV). Intra -and postoperative data were evaluated. Postoperative complications were assessed according to the Clavien–Dindo (C–D) classification.[28] Major complications were defined as C–D $\geq$ III. Length of stay was calculated from the day of surgery until discharge. In-hospital mortality was defined as death occurring after surgery and before patient discharge. Early patency was defined as adequate flow at the reconstruction site and the absence of thrombosis until postoperative day (POD) 30. Postoperative CT imaging was used to assess long-term patency. The change in SMV/PV diameter from preoperative to postoperative images was used to determine stenosis. The degree of stenosis was classified as grade A (0–49% reduction in diameter), grade B (50–69% reduction in diameter) or grade C ($\geq$70% reduction in diameter). The presence of grade C stenosis (severe stenosis) and/or the presence of a thrombus were considered clinically relevant.[29] Accordingly, grade C stenosis and/or the presence of thrombosis were considered not patent. Grade A and B stenosis was considered patent. Histologic diagnosis, tumor size, resection margins, the presence of positive lymph nodes and lymph node ratio were assessed. Resection margin status R1 was defined as tumor within 1 mm of the resection margin.

Surgical technique

The procedures for pancreatic surgery consisted of pancreatoduodenectomy with standard lymphadenectomy, or subtotal, total or distal pancreatectomy as deemed appropriate. A classic Whipple's procedure was the standard approach between 2006 and 2011, but from 2012 onward, this procedure was used only in patients with tumor involvement of the proximal duodenum or pylorus, while a pylorus-preserving procedure became the standard operation. The type of venous resection and reconstruction depended on the site and extent of tumor invasion of the vein. The length of the resected vein was not routinely measured. The decision on the reconstruction technique was based on intraoperative findings and the surgeon's preference, however, Cattell-Braasch mobilization was not routinely used. In general, the vein on either side of the tumor-involved segment was dissected free. In this way, inflow and outflow of the involved vein was secured, reducing potential bleeding and vascular clamp time. Splenic vein re-implantation or splenic vein preservation through an oblique transection line in the portal end of the resected vein was preferred. The artery-first approach was not routinely used, except for cases with SMV/PV TVI >180°, with occlusion, or with abutment of the superior mesenteric artery. Clamping of the superior mesenteric artery to reduce bowel ischemia was not used routinely. Perioperative use of heparin was administered on a routine basis. Iliac veins removed during multi-organ harvesting procedures by the transplantation unit were used as grafts. Immediately after harvesting, grafts were stored in University of Wisconsin solution at 4° C and matched to recipients according to the AB0-system. All anastomoses were performed free of tension with running 6-0 polypropylene sutures, and, in order to avoid any anastomotic stenosis, the anastomosis was expanded before complete revascularization by releasing the distal clamp first.

Postoperative management and surveillance

Patients remained in the postoperative ward for a minimum of one day. Doppler ultrasound of the reconstructed vein was performed routinely on POD 1. Patients were discharged to the local hospital or home as soon as the postoperative course was without suspicion of adverse events. Anticoagulation therapy with low-molecular heparin (LMWH) for a period of 1–3 months after surgery was recommended for all patients who had undergone reconstruction with an AG. The recommended LMWH dosage was 200 IE/kg for the first month and 100 IE/kg for the following two months. Lifelong aspirin at 75 mg daily was prescribed at the surgeon's discretion. Due to the retrospective nature of the study and the variety of pathology diagnoses, follow-up schedules varied. Local recurrence was defined as radiological evidence of intra-abdominal soft tissue in the resection area or along adjacent cardinal visceral vessels that (i) increased in size over time or (ii) had concomitant raised CA 19-9.[30] Biopsy to confirm recurrence was not routinely performed.

Statistical analysis

Graft patency and overall survival were estimated using the Kaplan–Meier method. Graft patency was calculated from the time of surgery to the last available CT. Survival was defined as the time from surgery to death of any cause or the end of follow-up through October 31, 2015, which ever came first. Continuous variables were expressed as median or mean with interquartile range (IQR) or standard deviation (SD). All analyses were performed using the SPSS version 22, for Microsoft Windows.