

## Vein reconstruction with cryopreserved vein allograft in pancreaticoduodenectomy. Pancreatic surgery

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### Summary

A cephalic pancreaticoduodenectomy is the only option for patients with periampullary tumours. In some cases, the relation of the head of the pancreas with neighbouring vascular structures (superior mesenteric vein, portal vein or their confluence), may be the cause, in some occasions, of carrying out a vascular resection in the same surgical procedure, due to tumour involvement, to achieve an R0 resection. Multiple options for vein reconstruction have been described, considering the extension, the length, and the location of vein resection. **Material and methods.** A retrospective analysis was carried out on patients undergoing a cephalic pancreaticoduodenectomy with concomitant vascular resection and venous reconstruction with cryopreserved venous allograft. Their clinical outcomes as well as their morbidity and mortality were analysed. The patency of the graft was evaluated with ultrasound and computed tomography. **Results.** We present

5 patients who underwent venous (portal vein/superior mesenteric vein) resection and reconstruction with cryopreserved vein allografts. The average surgical time was 430 minutes. The anatomopathological diagnoses were 2 pancreatic ductal adenocarcinomas, 2 cholangiocarcinomas and a neuroendocrine tumour. **Conclusion.** Our experience in vein reconstruction with cryopreserved vein allografts shows that it is a safe and viable technique to be conducted in institutions with experience in hepato-pancreatic-biliary surgery and organ transplant.

**Key words.** Allograft, cryopreservation, pancreatic cancer, pancreaticoduodenectomy, portal vein.

### Reconstrucción venosa con aloinjerto venoso criopreservado en duodenopancreatometomía. Cirugía pancreática

#### Resumen

La duodenopancreatometomía cefálica (DPC) es la única opción de cura en pacientes con tumores del área periampular. La relación de la cabeza del páncreas con estructuras vasculares vecinas (vena mesentérica superior, vena porta o su confluencia), conlleva, en algunas ocasiones, a realizar una resección vascular en el mismo acto quirúrgico, por compromiso tumoral, y así lograr una resección quirúrgica R0. Múltiples opciones para reconstrucción venosa han sido descritas teniendo en cuenta la extensión, la longitud y el sitio de resección venosa. **Material y métodos.** Se analizaron re-

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*trospectivamente los pacientes sometidos a DPC con resección vascular concomitante y reconstrucción venosa con aloinjerto venoso criopreservado. Se analizaron los resultados postoperatorios, la morbilidad y la mortalidad. La permeabilidad del injerto fue evaluada con ultrasonido y tomografía computada. **Resultados.** Se presentan 5 pacientes a los cuales se les realizó resección venosa (vena portal/ vena mesentérica superior) y reconstrucción con aloinjerto venoso criopreservado. El tiempo quirúrgico promedio fue de 430 minutos. Los diagnósticos anatomopatológicos fueron 2 adenocarcinomas ductales de páncreas, 2 colangiocarcinomas y un tumor neuroendocrino. **Conclusión.** Nuestra experiencia en reconstrucción venosa con aloinjerto venoso criopreservado expone que se trata de una técnica segura y factible de realizar en centros con experiencia en cirugía hepatobiliopancreática y trasplante de órganos.*

**Palabras claves.** Alograft, criopreservación, cáncer de páncreas, duodenopancreatectomía cefálica, vena porta.

The cephalic pancreaticoduodenectomy (CPD) is the only curative option in patients with pancreatic head tumours and in the periampullary area.<sup>1</sup> As pancreatic resections have become surgically safer, indications for pancreatectomies have increased, and surgical techniques have evolved. A greater number of indications for intraductal papillary mucinous neoplasms (IPMN) and other cystic neoplasms have been described, as well as for chronic pancreatitis and metastasis of the head of the pancreas.<sup>2</sup>

Currently, although surgical resection increases survival in patients with localized disease, only between 10 and 20% of patients may be operated on at the time of diagnosis.<sup>3</sup>

The relationship of the head of the pancreas with neighbouring vascular structures (superior mesenteric vein, portal vein or its confluence); leads, on some occasions, to the need to perform a vascular resection in the same surgical act, due to tumour compromise, and thus achieve a surgical resection R0.<sup>4</sup> Multiple options for vascular reconstruction have been described, considering the extension, length and site of the venous resection.

## Material and methods

From January 2012 to October 2017, a total of 93 CPD were performed in the Hospital Privado Universitario de Córdoba. A retrospective analysis was carried out on patients undergoing concomitant vascular resection and venous reconstruction with cryopreserved venous allograft.

All the patients were studied preoperatively with a physical examination, laboratory tests, three-phase computed tomography (CT) of abdomen and/or abdominal magnetic resonance, as well as computed tomography of the thorax for correct staging. Each case was discussed in an interdisciplinary oncology committee composed of specialists in surgery, radiology, oncology and gastroenterology, thus evaluating the vein-tumour interface in a detailed manner.

Preoperative biliary drainage (endoscopic or percutaneous), was not carried out systematically and only performed in those patients with doubts about the final management or in symptomatic patients with a projected surgery delay of more than fifteen days. The definition of the International Study Group for Pancreatic Fistula (ISGPF) was adopted for postoperative pancreatic fistula (PPF) and delayed gastric emptying (DGE).<sup>5,6</sup> Complications were analyzed according to the Clavien-Dindo classification, considering as major complications grades III a / b and IV a / b.<sup>7</sup>

Operative mortality was defined as, death occurring within 30 days of the surgery, or during hospital admission if it was more than 30 days. The patency of the vascular anastomosis was analysed initially with a Doppler ultrasound within 24 hours of the postoperative period. It was later evaluated twice with a CT, a month and three months after surgery.

All patients signed written informed consent for the surgical procedure.

## Surgical technique

The procedures that were carried out were CPD with pyloric preservation and standard lymphadenectomy; or Whipple procedure for cases in which, tumor involvement of the duodenum and/or pylorus was observed. The venous compromise was analyzed intraoperatively, and tangential or segmental resection was decided, based on the location and longitudinal and circumferential extension of the tumor lesion. Dissection and clamping were performed both, proximally and distally to the venous tumor compromise, to reduce potential bleeding during resection and reconstruction. The clamping time was monitored in all cases. When the venous resection was tangential without the possibility of performing a venorrhaphy due to venous caliber involvement, a cryopreserved venous graft patch was used. On the other hand, when the venous resection was segmental, the primary anastomosis of both ends was prioritized, and if not possible, a cryopreserved venous graft was interposed.

### Graft procurement

The venous allografts were obtained during liver harvesting procedures performed by the liver and renal pancreatic transplant service in our hospital. Both iliac veins were obtained in each procedure, which were preserved in the University of Wisconsin solution at 4° for a maximum of 15 days. The ABO compatibility of the graft was respected in all patients.

### Management and Postoperative Care

All patients underwent the immediate postoperative period in the Intensive Care Unit. Prophylaxis of deep vein thrombosis with low molecular weight heparin was started 24 hours postoperatively, depending on the Caprini score and the use of an epidural analgesia catheter by the anaesthesiology service, and antiaggregation was performed with 100 mg of acetylsalicylic acid every 24 hours from day 7 postoperatively, if there was no contraindication.

### Results

Portal vein (PV), superior mesenteric vein (SMV), or portomesenteric confluent (PMC) resection was performed in 17 (18%) of the 93 patients analyzed, due to intraoperative suspicion of tumor venous infiltration.

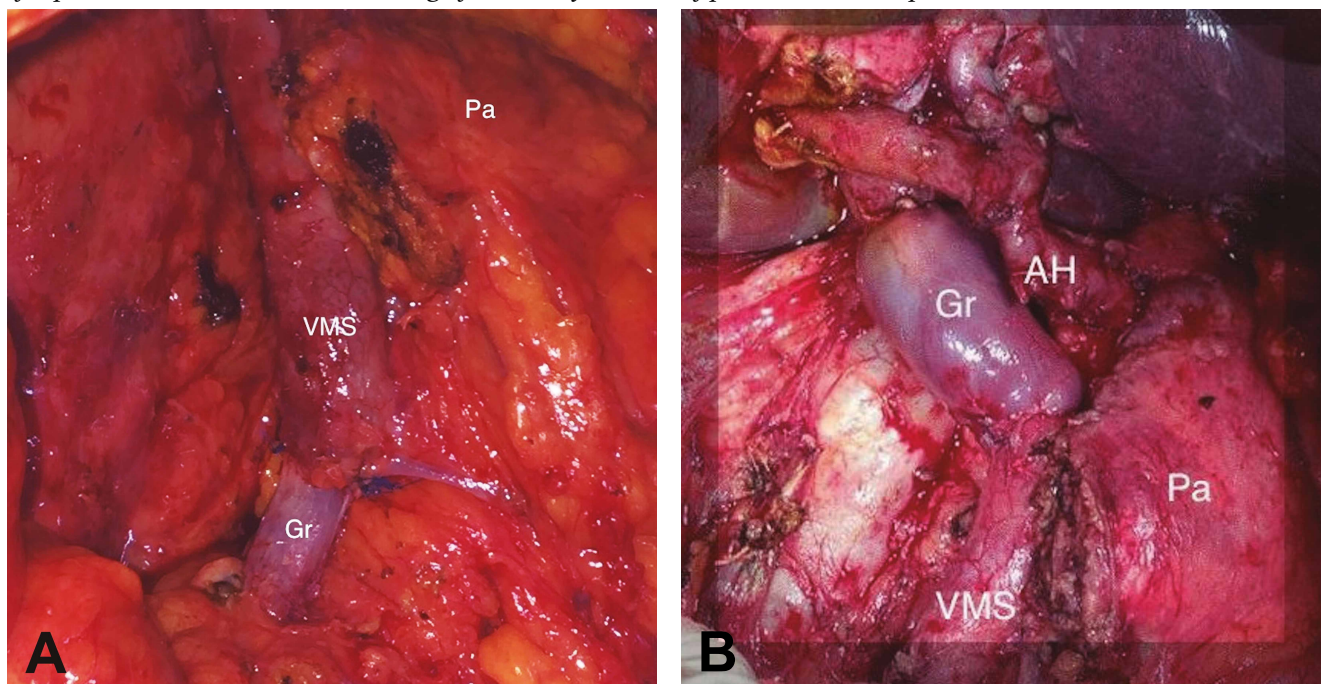
Of the latter 17 patients, 11 (63%) were reconstructed with primary lateral venorrhaphy or end to end anastomosis, 3 (18%) with politetrafluoroethylene (PTFE) and 5 (29%) received reconstruction with cryopreserved venous allograft.

Concerning about the cryopreserved venous allograft cases, 60% were men. The mean age of the patients undergoing surgery was 68 years (range: 56-75). The preoperative biliary drainage was performed in 1 case and no neoadjuvant chemotherapy was performed in any of them. The average surgical time was 430 minutes (range: 326-556) and 3 (60%) patients received transfusions during surgery.

Regarding venous resection, in 3 cases SMV resection was performed, 1 patient underwent PV resection and another at PMC resection (Figure 1). The average venous clamping time was 30 minutes (range: 25-40). In all cases the splenic vein was preserved, and in 1 patient the vein was reimplemented, because the resection compromised the union with the SMV.

The average time of hospitalization was 20 days (range: 13-30). Regarding morbidity, 40% (2 cases) presented major complications, PPF grade B in one patient and hospital-acquired pneumonia in the other. 2 patients (40%) presented DGE, which was resolved with medical treatment.

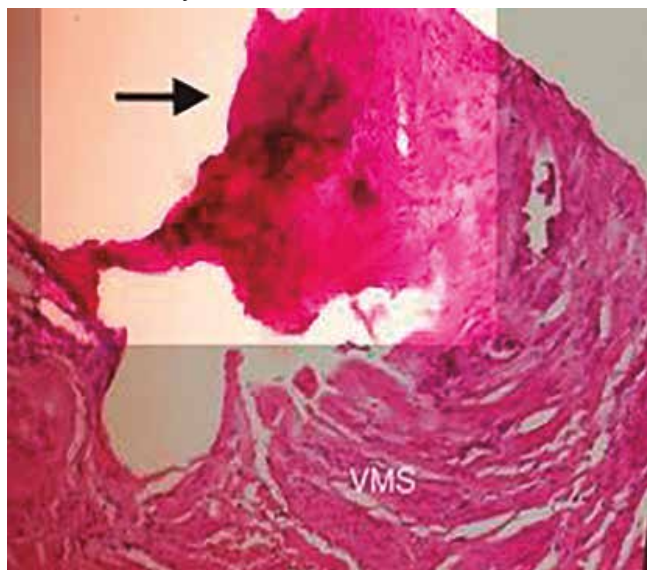
**Figure 1. A)** Intraoperative image after resection, where portal vein replacement is observed. Gr: venous graft. Pa: body and tail of pancreas. VMS: superior mesenteric vein. AH: Hepatic Artery. **B)** Ductal adenocarcinoma. Resection and replacement of superior mesenteric vein. Gr: venous graft. Pa: body and tail of pancreas. VMS: superior mesenteric vein.



A single patient presented thrombosis of the anastomosis, performing re-laparotomy, thrombectomy and systemic heparinization, but he evolved into multiorgan failure and died on day 12 of the postoperative period. Early patency using Doppler and late patency one and three months after the surgery showed no compromise in the remaining 4 (80%) patients.

The venous segment was resected together with the surgical piece and sent to pathological anatomy. The anatomopathological diagnoses were 2 (40%) pancreatic ductal adenocarcinomas (pT3N1, pT3N0), 2 (40%) distal cholangiocarcinomas (T3N1, T2N0) and 1 (20%) neuroendocrine tumour (T3N0) (Figure 2). Vein wall infiltration was observed in 4 (80%) of the patients. The 5 patients (100%) showed R0 resections.

**Figure 2.** Microscopy image in which, the wall of the superior mesenteric vein is observed, its infiltration by ductal adenocarcinoma (100X). VMS: superior mesenteric vein. Black arrow: venous infiltration due to ductal adenocarcinoma.



## Discussion

The invasion of neighboring vascular structures associated with pancreatic tumours is a problem that is frequently presented to the surgeon. Isolated tumoral infiltration of the porto-mesenteric venous axis is not an absolute contraindication for tumour resection with curative intent.<sup>8</sup>

Numerous retrospective studies affirm that, survival in patients undergoing CPD with venous resection com-

pared to those without it, did not turn out to be statistically significant, as well as the anatomopathological result of a R1 vs. R0 resection. However, CPD with venous resection has shown to increase resectability rates in pancreatic tumour pathology. On the other hand, advances in imaging techniques and postoperative care have shown a decrease in morbidity and mortality associated with venous resection, even matching those reported in surgeries without vascular resections.<sup>3, 9, 10</sup>

Various types of grafts have been described and used for venous reconstruction after portomesenteric resections, always taking into account the location and extent of tumour vascular involvement.<sup>11, 12</sup> In the case of segmental or tangential resections of short length, it is preferable to perform a primary end-to-end anastomosis or venorrhaphy, respectively, respecting the caliber and avoiding significant stenosis of the vein. Autologous vein grafts, such as the internal jugular vein, the inferior mesenteric vein, the superficial femoral vein, and the left renal vein; they proved to be a valid option, but they were associated with an increase in surgical time, the need for a second incision and complications at the graft extraction site.<sup>11, 12</sup> Other option is synthetic materials, such as polytetrafluoroethylene (PTFE), but they have not shown benefits with respect to autologous grafts.<sup>13</sup> Finally, the cryopreserved allografts have been used for venous reconstruction in various types of surgeries, starting with cadaveric donor liver transplantation and continuing with the contribution of Shi et al., who described the use of this type of grafts to reconstruct the middle suprahepatic vein in the right liver during living donor liver transplantation.<sup>14</sup> Then, in 2012, Meniconi et al.,<sup>2</sup> was the first to describe the use of cryopreserved venous allografts for venous reconstruction in CPD, reporting satisfactory results similar to those observed in our series with this technique. The benefits of allografts compared to other types of grafts are multiple. First of all, edema distal to venous extraction is avoided, as in the case of the autologous grafts; the risk of a second surgical site of infection is diminished, as well as the surgical time.<sup>15</sup>

In conclusion, we believe that such experience in venous reconstruction with cryopreserved venous allograft represents a feasible technique to perform in selected cases, in centres with experience in Hepatobiliopancreatic surgery and organ transplantation.

**Conflict of interest.** None declared.

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