Total Dorsal Pancreatectomy, an Alternative to Total Pancreatectomy: Report of a New Case and Literature Review

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Abstract
Background: Total dorsal pancreatectomy (TDP) is a conservative pancreatic resection that should be considered in cases of benign or low malignant tumors confined to the dorsal pancreas to preserve the viability of both digestive and biliary tracts, and to avoid the endocrine and metabolic consequences of total pancreatectomy. We report a new case of TDP and provide a literature review of this procedure.

Methods: The case reported was a 35-year-old female patient with a solid pseudopapillary tumor. We resected the dorsal segment of the pancreas while preserving the common bile duct, gastroduodenal artery, and pancreaticoduodenal arcades, and the spleen and splenic vessels. The MEDLINE® and Embase® databases were searched for English language studies, case series, or case reports published through August 31, 2017. Results: The postoperative course was uneventful and patient was discharged on postoperative day 11. The patient was alive and in good condition at the 10-year follow-up. To date in English literature, there are only 3 reported cases of TDP, and all cases were patients with intraductal papillary mucinous neoplasia and pancreas divisum. There was no postoperative mortality, and 2 grade B pancreatic fistulas healed 1 month postoperatively.

Conclusions: TDP is a feasible and safe operation for benign or low grade malignant pancreatic tumors involving the dorsal pancreas, as an alternative to total pancreatectomy.

Introduction

The toolkit of modern pancreatic surgeon should include conservative techniques, such as duodenum-sparing pancreatic head resection [1], spleen-preserving distal pancreatectomy [2], central pancreatectomy [3–8], resection of ventral pancreas or uncinate process [9, 10], mid-
dle-preserving pancreatectomy [11], total dorsal pancreatectomy (TDP) [12–14], and head dorsal pancreatectomy [15], as well as traditional pancreatic resection. In cases of benign or low grade malignant tumors confined to the dorsal pancreas, TDP should be considered to preserve the viability of both digestive and biliary tracts, and to avoid the endocrine and metabolic consequences of total pancreatectomy. The aims of this manuscript were to report a new case of TDP and to provide a literature review of this procedure.

Approval for TDP and this study was provided by our institutional ethics committee, and each patient or the patient’s family gave informed consent for the procedure, and to publish the details of their case. The MEDLINE® and Embase® databases were searched for English language studies, case series, or case reports published through August 31, 2017. Search terms were “dorsal pancreatectomy”, “total dorsal pancreatectomy”, “segmental pancreatic resection”, “conservative pancreatic surgery”, and “ventral-sparing pancreatectomy”. The reference lists of articles identified were manually searched to locate other articles of relevance.

Case Report

A 35-year-old female patient with persistent abdominal pain was referred to our hospital. Ultrasonography revealed an 8 cm pancreatic mass involving the dorsal head and neck of the pancreas (Fig. 1a). Computed tomography scan and abdominal magnetic resonance imaging (MRI) confirmed the presence of a pancreatic mass responsible for displacement to the right of the gastroduodenal artery (GDA) without signs of vascular infiltration and with hypertrophy of the ventral portion and uncinate process, atrophy of the body to tail (b and d), and which was responsible for displacing the pancreas to the right of the gastroduodenal artery (c).
The pancreatic region is reached by dissecting the gastroepiploic ligament, preserving the gastroepiploic vessels. Kocher’s maneuver should be avoided or carefully performed in order to preserve the posterior pancreaticoduodenal arcades. To identify the intra-pancreatic tract of the common bile duct (CBD) in the ventral segment, a catheter can be inserted into the CBD to the duodenum through the cystic duct; catheterization can also be performed after cholecystectomy. Alternatively, pre-operative endoscopic placement of biliary and/or pancreatic plastic stents can be performed to facilitate intra-operative identification of the CBD and the pancreatic duct. The common hepatic artery, GDA, anterior superior pancreaticoduodenal artery, and SA are identified and looped. The superior mesenteric vein is then dissected from the portal groove of the pancreatic neck. The pancreatic tail is mobilized while identifying and preserving the SA and splenic vein by ligating arterial and venous collateral branches.

Pancreatic resection is performed from left (tail) to right (head). At the head of the pancreas, the dorsal segment is dissected as described previously [15] stepwise from the duodenal wall toward the CBD plane while preserving the GDA and the anterior superior pancreaticoduodenal artery. Santorini’s duct is identified, dissected, and ligated at its outlet into the duodenum followed by dissection of the pancreatic parenchyma along the anterior surface of the CBD.

To complete the TDP, the fusion plane between dorsal and ventral segments is identified and carefully dissected. The main pancreatic duct in the ventral segment of the dissected parenchymal surface is identified, dissected, and ligated. Branch ducts identified on the surface of the ventral segment are then sutured in an interrupted pattern (Fig. 3). Frozen sections of the pancreatic parenchymal margin should be collected and analyzed in all cases.

**Literature Review**

To date in the literature, there are only 3 reported cases of TDP [12–14], and all 3 patients were diagnosed with intraductal papillary mucinous neoplasia (IPMN) with pancreas divisum (Table 1). Two patients had extensive intraductal mucinous tumors with areas of ranging from severe dysplasia to carcinoma in situ [12, 13], and 1 patient had non-invasive IPMN with foci of severe dysplasia involving several branch ducts and parts of the cephalic duct [14]. The transection margin was free of tumor in all cases. There was no postoperative mortality, and 2 grade B pancreatic fistulas healed 1 month after surgery [12, 14]. All patients were alive at the last reported follow-up. The first patient was alive 12 months postoperatively with insulin-dependent type II diabetes without exocrine insufficiency [12]; the second patient was alive 6 years postoperatively with insulin-dependent type II diabetes, signs of mild exocrine insufficiency, and without recurrence [13]; and the third patient was alive 18 months postoperatively with insulin-dependent type II diabetes without exocrine insufficiency and free of recurrence on MRI [14] (Table 1).
Discussion

Several authors recently reported successful conservative pancreatic resection of the dorsal segment, including the 3 cases of TDP [12–14], and 3 cases of partial dorsal pancreatectomy defined as ventral pancreas-preserving pancreatic head and body resection [16], anterior segmentectomy of the pancreatic head [17], and head dorsal pancreatectomy [15].

TDP is a conservative operation that allows for complete removal of the pancreatic mass while avoiding biliary and digestive tract resection/reconstruction and preserving endocrine and exocrine function. In selected cases, TDP represents the only alternative to total pancreatectomy and difficulties managing the subsequent “fragile” diabetes. Although postoperative diabetes was common in the reported cases of TDP, diabetes following TDP is easier to control than that resulting from total pancreatectomy because the glucose-stabilizing effects of glucagon may be maintained [12–14]. As reported in Table 1, all the patients submitted to TDP had a benign or low grade malignant tumor. In our opinion, a correct indication to TDP could be the presence of a benign or low malignant neoplasm, such as IPMN, pancreatic neuroendocrine tumors, and SPT confined in the dorsal segment of the pancreas without involvement of ventral segment or Wirsung’s duct, as an alternative of total pancreatectomy. In case of IPMN, if the entire main pancreatic duct is involved, ventral pancreas should not be preserved. In this case, duodenum preserving pancreatic resection could be considered [1]. In case of invasive or malignant neoplasm suspicious intraoperatively or at the frozen section, TDP should be converted to total pancreatectomy with standard lymphadenectomy. Moreover, according to the postoperative results reported in literature we can assume that TDP could be safely proposed with acceptable postoperative morbidity. No postoperative mortality has been reported with a rate of clinically significant pancreatic fistula of 50% (2/4) healed within one month by conservative management.

Anatomical and Embryological Bases

The pancreas is composed of 2 embryological segments, dorsal and ventral primordia. During the sixth week, the ventral primordium, together with the developing bile duct, rotates clockwise behind the duodenum and the dorsal primordium [18]. The differences in embryologic origins reflect histological characteristics. Compared with the dorsal pancreas, the ventral pancreas is characterized by the presence of smaller and more closely packed lobuli, irregular rather than uniform islets of Langerhans, and rich immunostaining with anti-pancreatic polypeptide [19]. Uchida et al. [19], Kimura and Nagai [20], and Sakamoto et al. [21] reported autoptical pancreatic anatomical studies on 20, 40, and 31 cases, respectively [19–21]. In each of these studies, the authors showed that the head of the pancreas can be removed while preserving vascular arcades and branches to the duodenum, the CBD, and the papilla of Vater [19], and that there is an anatomical fusion plane between the dorsal and ventral pancreas that contains small pancreatic ducts and vascular collateral branches [20, 21]. These studies confirm the theoretical feasibility of segmental pancreatic resection along this fusion plane. Resections of both the dorsal and ventral pancreas have been reported, demonstrating their technical feasibility and safety [9, 10, 21, 22].

The presence of pancreas divisum, the lack of fusion between the dorsal and ventral pancreas during embryological development, is a favorable anatomical condition that can allow pancreatic segmental resection; however, the procedure is possible even in the absence of this condition if the correct morphology of the pancreatic fusion plane is present [20, 21].

Technical Aspects

The first to describe and publish the surgical techniques of TDP was a group from the Massachusetts General Hospital in 2002 in an asymptomatic 71-year-old fe-
male with pancreas divisum, and an IPMN involving the dorsal segment [12]. However, according to the patient’s clinical history, it seems that TDP was performed for the first time in 1998 by Imrie et al. [13] although the authors published the case in 2005.

The technique described by Thayer et al. [12] provides the advancing of a catheter after cholecystectomy through the cystic duct into the CBD through the papilla into the duodenum to better identify the CBD during parenchymal dissection and to verify its integrity at the end of the operation. The authors also ligated the GDA to expose the supra-pancreatic portal vein and to facilitate dissection of the pancreatic neck. Pancreatic resection began at the pancreatic neck to allow for inspection and assessment of intraductal involvement of the tumor. In patients with pancreas divisum, the fusion plane between dorsal and ventral segments at the pancreatic head was easily identified at the superior-posterior portion of the pancreas and was described as a fibrous septum that allowed relatively simple and bloodless dissection and separation of the pancreatic segments along a plane passing through the anterior surface of the CBD, which was entirely preserved. The dorsal segment was dissected en-bloc with the minor papilla, and the body and tail of the pancreas were then removed while preserving the spleen, using Warshaw’s technique [2]. On completion of the surgery, the first portion of the duodenum developed ischemic injury that necessitated resection of the dorsal segment of the head and the body tail is controversial. There are no clear advantages of this technique compared with en-bloc resection as we and Sauvanet and colleagues [14] propose. Third, spleen preservation with ligation of the splenic vessels is a feasible and safe technique but it should be reserved for specific cases because splenic infarcts and abscesses have been reported [2, 23, 24].

The case reported by Talbot et al. [13] suffered a long and troubled diagnostic process and was characterized by issues similar to the previous case with 2-step pancreatic dorsal segment resection after parenchymal transection at the neck and the need for digestive reconstruction (because of previous endoscopic cystic duodenal drainage). During laparotomy and after excision of the previous cystojejunostomy, differing firmness in the ventral and the dorsal pancreas suggested the authors to perform a TDP. Pancreatic resection began with parenchymal transection at the neck as described by Thayer et al. [12] and proceeded with resection of the dorsal segment along the embryological fusion plane between the ventral and the dorsal segments. The second portion of the duodenum and the retro-duodenal portion of the CBD were then resected followed by resection of the pancreatic body and tail while preserving the spleen and its vessels. Digestive and biliary continuity was ensured by an end-to-end duodenum-jejunal anastomosis and an end-to-side bile duct-jejunal anastomosis.

From a technical perspective, the procedure proposed by Scatton et al. [14] was performed more correctly. Kocher’s maneuver was not performed and both the GDA and the posterior pancreaticoduodenal arcade were preserved to minimize the risk of duodenal ischemia. After mobilizing and tapering the pancreatic neck, pancreatic transection began 2–3 mm from the duodenal wall along a plane passing through the

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Age</th>
<th>Gender</th>
<th>Histology</th>
<th>Pancreatic fistula</th>
<th>Exocrine insufficiency</th>
<th>Diabetes</th>
<th>Survival, months</th>
</tr>
</thead>
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<tr>
<td>Thayer et al. [12]</td>
<td>2002</td>
<td>71</td>
<td>Female</td>
<td>IPMN</td>
<td>Grade B</td>
<td>–</td>
<td>+</td>
<td>12, alive</td>
</tr>
<tr>
<td>Talbot et al. [13]</td>
<td>2005</td>
<td>51</td>
<td>Female</td>
<td>IPMN</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>76, alive</td>
</tr>
<tr>
<td>Scatton et al. [14]</td>
<td>2006</td>
<td>45</td>
<td>Male</td>
<td>IPMN</td>
<td>Grade B</td>
<td>–</td>
<td>+</td>
<td>18, alive</td>
</tr>
<tr>
<td>Current case</td>
<td>2018</td>
<td>35</td>
<td>Female</td>
<td>SPT</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>120, alive</td>
</tr>
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IPMN, intraductal papillary mucinous neoplasia; SPT, solid pseudopapillary tumor.
anterior surface of the CBD. The dorsal pancreatic duct was divided and ligated 3 mm away from the duodenal lumen, and TDP was completed by resecting the pancreatic body and tail while preserving the spleen and its vessels.

In our patient, we performed pancreatic resection from left to right after complete mobilization of the pancreatic body and tail. As suggested by Scatton et al. [14] we carefully preserved the GDA and avoided Kocher’s maneuver.

Conclusions
Our case and previously reported cases confirm that TDP is a feasible and safe operation for benign or low malignant pancreatic tumors involving the dorsal pancreas as an alternative to total pancreatectomy.

Disclosure Statement
The authors declare no conflicts of interest.

References