
Distal Pancreatectomy: A Single Institution's Experience in Open, Laparoscopic, and Robotic Approaches



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- BACKGROUND:** The indications for minimally invasive (MIS) pancreatectomy have slowly increased as experience, techniques, and technology have improved and evolved to manage malignant lesions in selected patients without compromising safety and oncologic principles. There are sparse data comparing laparoscopic, robotic, and open distal pancreatectomy (DP).
- STUDY DESIGN:** All patients undergoing DP at Memorial Sloan Kettering Cancer Center between 2000 and 2013 were analyzed from a prospective database. Clinicopathologic and survival data were analyzed to compare perioperative and oncologic outcomes in patients who underwent DP via open, laparoscopic, and robotic approaches.
- RESULTS:** Eight hundred five DP were performed during the study period, comprising 37 robotic distal pancreatectomies (RDP), 131 laparoscopic distal pancreatectomies (LDP), and 637 open distal pancreatectomies (ODP). The 3 groups were similar with respect to American Society of Anesthesiologists (ASA) score, sex ratio, body mass index, pancreatic fistula rate, and 90-day morbidity and mortality. Patients in the ODP group were generally older ($p = 0.001$), had significantly higher intraoperative blood loss ($p < 0.001$), and had a trend toward a longer hospital stay ($p = 0.05$). Of the significant preoperative variables, visceral fat was predictive of conversion on multivariate analysis ($p = 0.003$). Oncologic outcomes in the adenocarcinoma cases were similar for the 3 groups, with high rates of R0 resection (88% to 100%). The ODP group had a higher lymph node yield than the LDP and RDP groups (15.4, [SD 8.7] vs 10.4 [SD 8.0] vs 12[SD 7.2], $p = 0.04$).
- CONCLUSIONS:** The RDP and LDP were comparable with respect to most perioperative outcomes, with no clear advantage of one approach over the other. Both of these MIS techniques may have advantages over ODP in well-selected patients. All approaches achieved a similarly high rate of R0 resection for patients with adenocarcinoma. (J Am Coll Surg 2015;220:18–27. © 2015 by the American College of Surgeons)
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Distal pancreatectomy (DP) for surgically resectable benign and malignant lesions in the body and tail of the pancreas is a common but potentially challenging

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surgical procedure that has traditionally been performed via the open approach. It is associated with significant morbidity rates and mortality of up to 5%.^{1,2} The first laparoscopic distal pancreatectomy (LDP) was performed in 1994 by Cuschieri.³ Gagner and colleagues⁴ subsequently reported their initial experience with laparoscopic DP in 8 patients. Initial concerns regarding compromise of objective and measurable oncologic outcomes, such as adequacy of surgical margin and lymph node (LN) retrieval, retarded the progress of minimally invasive surgery (MIS) techniques in the treatment of pancreatic malignancies. Since then, laparoscopic techniques have been adopted exponentially as experience, technique, and technology have improved. Studies have demonstrated that

Abbreviations and Acronyms

ASA	= American Society of Anesthesiologists
DP	= distal pancreatectomy
LDP	= laparoscopic distal pancreatectomy
LN	= lymph node
MIS	= minimally invasive surgery
MSKCC	= Memorial Sloan Kettering Cancer Center
ODP	= open distal pancreatectomies
PDAC	= pancreatic ductal adenocarcinoma
RDP	= robotic distal pancreatectomy

laparoscopic techniques have smaller incisions, faster patient recovery, and shorter hospital stays, with comparable mortality and morbidity rates without compromising oncologic outcomes.⁵⁻⁸

Robotic surgery is the latest development in minimally invasive techniques for pancreatic surgery, with the first series of 13 robotic pancreatic resections published by Giulianotti and associates⁹ in 2003. Since then, several groups have reported experience with robotic assisted pancreaticoduodenectomy.¹⁰ Although robotic surgery theoretically retains the benefits of laparoscopic techniques with regard to smaller incisions, shorter hospitalization periods, and faster patient recovery, there are several additional technical advantages over laparoscopic techniques that make it potentially advantageous.¹¹ This includes a 3-dimensional (3D) high definition surgical view, tremor filtration, motion scaling, improved surgeon ergonomics, and significantly increased range of motion due to an internal articulated EndoWrist (Intuitive Surgical).^{12,13} However, this new platform has raised many concerns among surgeons on the lack of tactile feedback, higher costs, and longer surgical time as compared with conventional laparoscopic or open surgery.¹³⁻¹⁷

This study was conducted to compare the perioperative variables and early outcomes of patients undergoing distal pancreatectomy in our institution via the open, laparoscopic, or robot-assisted approaches.

METHODS

This was a retrospective review of all distal pancreatic resections performed at the Department of Surgery, Memorial Sloan Kettering Cancer Center (MSKCC) between January 1, 2000 and August 31, 2013. Institutional review board approval was obtained before the study. Patients were selected from a prospectively maintained database and were included if they had a DP with or without splenectomy. Patients with additional organ resection at the same setting were excluded from this analysis. Variables examined including age, sex, body mass

index (BMI), American Society of Anesthesiologists (ASA) score, surgical approach (open, laparoscopic, robotic, reasons for conversion if any), operative time, estimated blood loss (EBL), pancreatic consistency, and technique of remnant closure were recorded, as well as the length of hospital stay (LOS). To study obesity as a potential risk factor for conversion, we used retrorenal visceral fat thickness as a surrogate for the degree of visceral fat mass. This was defined and measured as the vertical distance between the left posterior renal capsule and the junction of the abdominal wall and paraspinal musculature at the level of the left renal vein.¹⁸

Pathologic data were also captured and included histopathologic diagnosis; in patients who had adenocarcinoma, margin status, LN evaluated, and numbers of positive nodes were also studied. Postoperative morbidity and mortality were defined as complications or deaths within 90 days after surgery, respectively. Postoperative morbidity and mortality were recorded prospectively into the Department of Surgery complication database (MSKCC Surgical Secondary Events Program). This standardized system of complication reporting has been validated and grades the severity of these events by using a therapy-oriented 5-point grading system with a score of 1 to 5, ranging from those requiring minor or no interventions such as oral antibiotics, bowel rest, or basic noninvasive monitoring (grade 1), to those leading to death (grade 5).^{19,20} Intra-abdominal abscess is defined and recorded if there are clinical signs or symptoms or radiologic diagnosis of intra-abdominal abscess or peritonitis such as fever, elevated white cell count, and positive fluid cultures. Intra-abdominal abscesses were similarly graded using this classification system. Pancreatic fistula is defined as the presence of clinical signs or symptoms with amylase-rich drainage >50 mL/d beyond postoperative day 10 without signs and symptoms of infection.²¹ Severity of the pancreatic fistula was defined by the International Study Group on Pancreatic Fistula (ISGPF) grading system.²²

Surgical techniques for open and laparoscopic DP at MSKCC have been previously described.²³ Robotic distal pancreatectomy (RDP) cases were performed with the da Vinci system (Intuitive Surgery). Typically, 4 to 5 ports were used (3 8-mm; 2 12-mm), as well as 3 robotic arms and 1 laparoscopic port (an accessory port for the assistant). After port placement and induction of pneumoperitoneum, the robot (Si model) was docked into position (Fig. 1). Dissection and resection used techniques similar to those in our approach for LDP. Once the gland was divided and hemostasis secured, the robot was undocked and the specimen was extracted in a plastic bag laparoscopically. All surgeons

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