The American Journal of Surgery (2016) 211, 871-876

The American Journal of Surgery®

North Pacific Surgical Association

Preoperative computed tomography scan to predict pancreatic fistula after distal pancreatectomy using gland and tumor characteristics

Zeljka Jutric, M.D.[a,b], W. Cory Johnston, M.D.[a,b], Jan Grendar, M.D., M.Sc.[a,b], Leah Haykin, B.S.[a], Connor Mathews, B.S.[b], Liv K. Harmon, M.D.[d], Jian Shen, M.D.[b], Hejin P. Hahn, M.D., Ph.D.[d], David L. Coy, M.D., Ph.D.[d], Maria A. Cassera, B.S.[a], W. Scott Helton, M.D.[d], Flavio G. Rocha, M.D.[d], Ronald F. Wolf, M.D.[a,b,c], Paul D. Hansen, M.D.[a,b,c], Chet W. Hammill, M.D., M.S.[a,b,c], Adnan A. Alseidi, M.D.[d], Pippa H. Newell, M.D.[a,b,c,*]

[a]Hepatobiliary and Pancreatic Surgery Program, Providence Cancer Center, 4805 NE Glisan Street, Suite 6N50, Portland, OR 97213, USA; [b]Department of General, Thoracic and Vascular Surgery, Providence Cancer Center, 4805 NE Glisan Street, Suite 6N50, Portland, OR 97213, USA; [c]Gastrointestinal and Minimally Invasive Surgery Division, The Oregon Clinic, 4805 NE Glisan Street, Suite 6N60, Portland, OR 97213, USA; [d]Virginia Mason Medical Center, Seattle, WA, USA

KEYWORDS:
Distal pancreatectomy;
Pancreatic fistula;
Risk factors

Abstract

BACKGROUND: Preoperative risk stratification for postoperative pancreatic fistula in patients undergoing distal pancreatectomy is needed.

METHODS: Risk factors for postoperative pancreatic fistula in 220 consecutive patients undergoing distal pancreatectomy at 2 major institutions were recorded retrospectively. Gland density was measured on noncontrast computed tomography scans (n = 101), and histologic scoring of fat infiltration and fibrosis was performed by a pathologist (n = 120).

RESULTS: Forty-two patients (21%) developed a clinically significant pancreatic fistula within 90 days of surgery. Fat infiltration was significantly associated with gland density ($P = .0013$), but density did not predict pancreatic fistula ($P = .5$). Recursive partitioning resulted in a decision tree that predicted fistula in this cohort with a misclassification rate less than 15% using gland fibrosis (histology), density (HU), margin thickness (cm), and pathologic diagnosis.

The authors declare no conflicts of interest.
This article will be presented at the North Pacific Surgical Association.
* Corresponding author. Tel.: +1-503-281-0561; fax: +1-503-416-7377.
E-mail address: philippa.newell@gmail.com
Manuscript received November 18, 2015; revised manuscript February 3, 2016

http://dx.doi.org/10.1016/j.amjsurg.2016.02.001

CONCLUSIONS: This multicenter study shows that no single perioperative factor reliably predicts postoperative pancreatic fistula after distal pancreatectomy. A decision tree was constructed for risk stratification.

The incidence of pancreatic fistula after distal pancreatectomy (DP) remains high, with reported rates of 16% to 30% in the literature.[1,2] A significant improvement in mortality after both proximal and DP has been observed as a result of patient selection and advancements in surgical technique and postoperative care. Postoperative morbidity has not followed the same trend.[3] Postoperative pancreatic fistula remains the dominant cause of morbidity after DP and can be associated with life-threatening complications, such as intra-abdominal abscess, hemorrhage, and sepsis.[2,4]

Several validated models have been implemented to aid in patient selection for pancreatectomy. These include the American Society of Anesthesiologists class, the Charlson score, and the Risk Calculator published by the American College of Surgeons National Surgical Quality Improvement Program. These are valuable tools for general patient selection but may underestimate the pancreatectomy-specific events.[5] Therefore, assessment of preoperative and intraoperative pancreatectomy-specific risk factors is important to (1) stratify patients in clinical trials testing methods to reduce the risk of pancreatic fistula and (2) inform patients accurately about the potential risks of the procedure.

Many predisposing risk factors for pancreatic fistula after pancreatectomy have been proposed. Preoperative patient-specific factors associated with pancreatic fistula include body mass index, advanced age, and diabetes.[6] Intraoperative anatomic features of the pancreatic remnant, including small pancreatic duct, thick pancreatic remnant, soft pancreatic texture, and fatty infiltration of the pancreatic tissue, have been shown in retrospective studies to be associated with pancreatic fistula.[7–11] Pancreatic steatosis particularly has peaked the interest of several authors because of its possible association to soft pancreatic texture and, therefore, with pancreatic fistula.[3,12,13] Mathur et al[13] suggests that fatty infiltration increases the risk of pancreatic fistula because it increases softness of the gland. Furthermore, increased body mass index has been associated with histologic fatty infiltration of the pancreas in both proximal and distal pancreatic resections.[3,14,15] Here lies the challenge of predication of postoperative pancreatic fistula: the strongest risk factors for pancreatic fistula have thus far been factors that are determined intraoperatively, rather than preoperatively.

The ability of various imaging techniques to detect and quantify degrees of hepatic steatosis has been studied and quantified previously.[16–18] The relationship between body mass index and fat content of pancreas and other solid organs has been observed using magnetic resonance imaging.[19] Roberts et al[6] sought to determine if measurement of pancreatic tissue density on unenhanced computed tomography (CT) scan predicts the risk of postoperative pancreatic fistula and found that although density was positively associated with fistula, they were unable to determine a relationship with steatosis because of lack of histologic assessment of the resected specimens. Otherwise, there are limited data addressing pancreas imaging density and risk of postoperative pancreatic fistula.

In this study, we investigated whether pancreatic tissue density in Hounsfield units as measured on preoperative radiologic imaging by noncontrast CT would correlate with intraoperative findings and histologic features of pancreas gland fibrosis and fat infiltration, such that CT could be used as a method to predict pancreatic fistula postoperatively.

Methods

All patients undergoing DP at 2 institutions (Providence Portland Cancer Center, Portland, OR, and Virginia Mason Medical Center, Seattle, WA) from 2007 to 2012 were identified (n = 199). The study was approved by the institutional review board of both institutions. Patient medical records and diagnostic imaging studies were retrospectively reviewed. The presence of a pancreatic fistula postoperatively was graded according to the International Study Group on Pancreatic Fistula (ISGPF).[20] Statistical analyses focused on the presence of clinically significant pancreatic fistula (ISGPF grades B and C).

Gland density was measured on noncontrast CT scans (n = 101) by 4 researchers blinded to the clinical outcome, and this variable was not measured in patients lacking noncontrast CT imaging (n = 119). Tissue density at the estimated pancreatic resection line was measured in Hounsfield units using unenhanced preoperative CT images. When lesions to be resected were not visible on noncontrast CT, the estimated transection line was determined on contrast-enhanced images. Average density measurement (in HU) of 3 overlapping regions of the estimated resection margin on preoperative unenhanced CT scans was recorded. Additionally, thickness of pancreas on preoperative unenhanced CT scans at the estimated resection line (anterior–posterior in millimeters) was measured.

Final histologic diagnoses from the pathology report (adenocarcinoma, cystic, neuroendocrine, pancreatitis, other) were obtained. Histologic slides from resected specimens were scored for fibrosis and fat infiltration at the resection margin using standardized scales listed in Table 1.[21] Histologic scoring of fat infiltration and fibrosis was performed by a pathologist blinded to the clinical outcomes based on hematoxylin and eosin staining (n = 120). Fat infiltration score at the histologic margin (0, 1, 2, 3, 4) based on both intralobular and interlobular fat infiltration was measured and the fibrosis score at the histologic margin (0, 1, 2, or 3) (Table 1).

Additional data points collected include demographics, ASA classification, presence of diabetes, operative approach, inclusion of splenectomy, method of pancreas transection, method of pancreatic stump closure, type of sealant used