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ORIGINAL ARTICLE

Assessing the impact of conversion on outcomes of minimally invasive distal pancreatectomy and pancreatoduodenectomy

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Abstract

Background: Our aim was to compare outcomes of patients who undergo conversion to open during minimally invasive distal pancreatectomy (MI-DP) and pancreatoduodenectomy (MI-PD) to those completed in minimally invasive fashion, and to compare outcomes of minimally invasive completions and conversions to planned open pancreatectomy.

Methods: Propensity scoring was used to compare outcomes of completed and converted cases from a national cohort, and multivariate regression analysis (MVA) was used to compare minimally invasive completions and conversions to planned open pancreatectomy.

Results: MI-DP was performed in 43.0%. Conversions (20.2%) had increased morbidity (32.3 vs 42.0%), serious morbidity (11.1 vs 21.2%), and organ space infection (6.2 vs 14.2%). Outcomes of MI-DP conversions were comparable to open. MI-PD was performed in 6.1%. Conversions (25.2%) had increased organ space infection (10.9 vs 26.6%), blood transfusions (17.2 vs 42.2%), and clinically relevant pancreatic fistula (11.5 vs 28.1%). On MVA, conversion of MI-PD was associated with increased mortality (OR 2.84, 95% CI 1.09–7.42), post-operative percutaneous drain placement (OR 2.36, 95% CI 1.32–4.20), and blood transfusions (OR 1.85, 95% CI 1.07–3.21).

Conclusion: Converted cases have increased morbidity compared to completions, and for patients undergoing PD, conversions may be associated with inferior outcomes compared to planned open cases.

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Introduction

Minimally invasive distal pancreatectomy (MI-DP) and pancreatoduodenectomy (MI-PD) are being increasingly adopted in the hopes of improving patient outcomes.[1] Laparoscopic and robotic approaches remain the two most widely used platforms, with multiple reports from high volume centers indicating improved outcomes compared to open pancreatectomy in select cases.[1–5] Although comparative effectiveness studies between both platforms are lacking, recent evidence from an American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) study suggests the robotic approach to be associated with reductions in conversion to laparotomy compared to its laparoscopic counterpart.[6]

The impact of conversions on postoperative outcomes for other minimally invasive procedures is well-established and includes increased overall morbidity, surgical site infections, and prolonged length of stay.[7,8] While predictors of conversion for minimally invasive to open pancreatectomy have been reported, the impact of conversion on post-operative morbidity remains unknown.[6,9] Both laparoscopic and robotic DP and PD are associated with long learning curves that entail a significant conversion rate for early adopters.[10–12] The rate and impact of these conversions on outcomes of distal pancreatectomy and pancreatoduodenectomy (within the learning curve and beyond) may influence the decision of various stakeholders on which platform to adopt, and better inform patients on the potential risks and benefits of minimally invasive pancreatic surgery.

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Based on the increasing adoption of minimally invasive pancreatectomy and the lack of data on the impact of conversions, we aimed to first compare outcomes of minimally invasive DP and PD conversions to those completed in minimally invasive fashion in a large national cohort, and second, compare the outcomes of minimally invasive completions and conversion to planned open pancreatectomy. We hypothesized that conversions would be associated with worse outcomes compared to completed cases, and that converted cases may even portend poorer outcomes compared to those undergoing planned open pancreatectomy.

Methods

Study population

The American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) Participant Use File 2014–2015 was queried to identify patients having undergone minimally invasive pancreatectomy (MIP). MIP included laparoscopic and robotic pancreatoduodenectomy (MI-PD) and distal pancreatectomy (MI-DP). CPT's included for MI-DP were 48,140 and CPT's used for MI–PD were 48,150 and 48,153. Patients with a hybrid approach, any 'assisted' approaches, and other concomitant organ resections were excluded. Patients were also excluded if their surgery was not elective, they met criteria for a systemic inflammatory response syndrome or sepsis at the time of surgery, had a preoperative wound infection, were not independent at baseline, or had a history of congestive heart failure, ascites, renal failure (and/or on dialysis), dyspneic at rest, or were on a ventilator at the time of surgery. This study was designated exempt from review by the Institutional Review Board at the participating institutions.

Surgical outcomes

In addition to the standard ACS-NSQIP variables, pancreas-specific variables (from the ACS-NSQIP Pancreatectomy Targeted Participant Use File) were collected and included as part of the analysis. These variables include the presence of preoperative jaundice or a biliary stent, chemotherapy in the 90 days prior to surgery and radiation in the 90 days before surgery, surgery type, pancreatic duct size, pancreatic gland texture, vascular resection, method of pancreatic reconstruction and drain placement, drain amylase on post-operative day one, pancreatic fistula, delayed gastric emptying and percutaneous drainage. The definition of clinically relevant-post-operative pancreatic fistula (CR-POPF) was the presence of fistula in addition to either a drain in place >21 days with a hospital length of stay of at least 14 days, organ space surgical site infection, postoperative percutaneous drain placement, reoperation, sepsis, shock, or multisystem organ failure (respiratory or renal failure).[13–15] Serious morbidity has been defined previously and included organ space SSI, wound dehiscence, neurological event (stroke or cerebrovascular accident, coma>24 h, peripheral neurological deficit), cardiac arrest, myocardial infarction (MI), pulmonary embolism (PE), ventilator dependent, progressive or acute renal insufficiency, sepsis or septic shock (14). Overall morbidity included any serious morbidity, as well as superficial or deep incision SSI, pneumonia, unplanned reintubation, urinary tract infection (UTI), and deep venous thrombosis (DVT).

Statistical analysis

To explore the impact of minimally invasive conversions a 1:1 propensity score matched analysis was performed for converted and completed cases. Variables readily available to the surgeon were used in the model, and included age of the patient, race/ethnicity, gender, BMI, history of diabetes, tobacco use, functional status prior to surgery, ASA, presence of preoperative jaundice, preoperative biliary stent utilization, and neoadjuvant therapy. Neoadjuvant therapy included the administration of chemotherapy and/or radiation therapy in the preoperative setting. Intraoperative factors such as performance of a vascular resection, length of operation, and pancreatic gland texture/duct size were also used for scoring. Differences in final pathology between MI-DP completed and MI-DP converted cohorts (but not for PD) were statistically significant and to remove this as a confounding variable, final pathology was added to the model for derivation of propensity scores. Once the propensity scores were derived, a nearest neighbor-matching algorithm was used to match patients requiring conversion to an open approach to those that were completed using a minimally invasive approach.

To compare outcomes of converted, completed and open cases, a multivariable logistic regression was performed to determine the impact of operative approach on morbidity adjusting for differences in baseline comorbidities. All prior baseline comorbidities were included for evaluation for inclusion in the final model. A stepwise selection criteria was used to determine final covariates included with an entry criterion of a p-value of 0.25 and exit criteria of 0.20. Hosmer–Lemeshow Goodness of Fit tests were performed for each model.

Continuous variables are expressed as median with range or mean ± standard error of mean (SEM) depending on normality and compared using the Student's *t*-test or Wilcoxon rank sum as appropriate. Categorical variables are expressed as number or percentage and were compared using two-sided Fisher's exact and/or Chi-squared test as appropriate. Statistical significance was set at $p \leq 0.05$. All analyses were performed on SAS version 9.4 (Cary, NC).

Results

Patient demographics and unadjusted outcomes

Minimally invasive pancreatectomy was performed in 17.5% (n = 1581) of 9031 cases. MI-DP was performed in 43.0% (n = 1200/2787) of which 79.8% (n = 958) were completed in minimally invasive fashion, and 20.2% (n = 242) were converted to open. MI-PD was performed in 6.1% (n = 381/6244), of

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