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ORIGINAL ARTICLE

A comparison of outcomes between open, laparoscopic and robotic pancreaticoduodenectomy

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Abstract

Background: The advantages and comparison of minimally invasive techniques for pancreaticoduodenectomies have not been fully explored using large national multicenter data.

Study design: A retrospective review of NSQIP targeted data from 2014 to 2015 was performed. Demographics and outcomes were compared between open (OPD), laparoscopic (LPD) and robotic pancreaticoduodenectomies (RPD).

Results: Of 6827 pancreaticoduodenectomies, 6336 (92.8%) were OPD, 280 (4.1%) were LPD, and 211 (3.1%) were RPD. Compared to OPD, LPD required more post-operative drainage procedures (18.4% vs 13.2%, $p = 0.013$), had less SSI (3.2% vs 9%, $p = 0.001$), and had fewer discharges to a new facility (8.1% vs 13%, $p = 0.018$). Compared to OPD, RPD had less perioperative transfusions (14.2% vs 20.5%, $p = 0.026$) and more readmissions (23.2% vs 16.7%, $p = 0.013$). After controlling for differences, LPD was independently associated with decreased 30-day morbidity compared to OPD (OR 0.75, 95% CI 0.56–0.99). There was no difference in 30-day mortality.

Conclusions: This is the first study to compare the outcomes of laparoscopic and robotic pancreaticoduodenectomies to open using the NSQIP database. After controlling for differences between groups, LPD is independently associated with less morbidity. In experienced hands, it appears safe and valuable to pursue refinement of minimally invasive techniques for pancreaticoduodenectomies.

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Introduction

Attempts at minimally invasive pancreaticoduodenectomies (MPD) started in 1994 with the first description of a laparoscopic pancreaticoduodenectomy (LPD).[1] Almost a decade later in 2003 the first description of a robotic pancreaticoduodenectomy (RPD) was reported.[2] Over recent years, there have been many additions to the literature regarding minimally invasive approaches to pancreaticoduodenectomy,[3–9] however, these have largely been limited to single center experiences or only compare one minimally invasive technique to open pancreaticoduodenectomies (OPD). Additionally, larger multi-institutional studies are limited to either systematic reviews[10] or combine robotic and laparoscopic data together[5,11] which limits the ability to interpret the data.

As multi-institutional data comparing both laparoscopic and robotic to open is lacking, we sought to look at the individual short-term outcomes of open, laparoscopic and robotic pancreaticoduodenectomies. In this study, we utilized the ACS NSQIP data to look at the 30-day morbidity, mortality and discharge disposition of patients undergoing pancreaticoduodenectomy. Similar to single institution studies, we hypothesize that the short-term outcomes will be similar between groups.

Materials and methods

After obtaining institutional IRB approval, a retrospective review was conducted using the NSQIP Participant Use File and the procedure-targeted pancreatic data for the years 2014 and 2015.

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The procedure-targeted data from 2014 to 2015 included data from 106 to 120 surgical sites, respectively. Data for the two years was combined and the database was queried for the CPT codes specific to pancreaticoduodenectomy (48150, 48152, 48153, 48154). Patients were then divided into groups based on the operative approach in an intention to treat analysis. Laparoscopic procedures include those classified as Laparoscopic, Laparoscopic with Open Assist and Laparoscopic with Unplanned Conversion to Open. Similarly, Robotic procedures include those classified as Robotic, Robotic with Open Assist and Robotic with Unplanned Conversion to Open. Hybrid procedures were excluded.

Variables and outcome measures

The main study outcomes were mortality within 30 days of surgery and the incidence of one or more postoperative events. Patient demographics, co-morbidities, operative factors and outcomes of were extracted. Demographics included Age, Sex, Race. Pre-existing co-morbidities included Body Mass Index (BMI), history of diabetes, smoking, dyspnea, functional status, congestive heart failure (CHF), hypertension (HTN), chronic obstructive pulmonary disease (COPD), dialysis dependence, disseminated cancer, steroid use, unintentional weight loss, bleeding disorders, ascites, ASA class, malignant disease, preoperative jaundice, preoperative chemotherapy and preoperative radiation and T-stage. Operative factors included case contamination (both contaminated and dirty cases were combined as "contaminated/dirty") and performance of vascular resection. We defined postoperative events as the following complications recorded by NSQIP: presence of a pancreatic fistula, delayed gastric emptying, need for post-operative percutaneous drain, superficial surgical site infection (SSI), deep surgical site infection, organ space infection, wound disruption, pneumonia, unintended reintubation, pulmonary embolus (PE), failure to wean from the ventilator, renal insufficiency, renal failure, urinary tract infection (URI), cerebral vascular accident (CVA), cardiac arrest, myocardial infarction (MI), intraoperative or postoperative bleeding, deep vein thrombosis (DVT), postoperative sepsis, postoperative shock, reoperation, related readmission, overall morbidity, and death. Overall morbidity was defined as any of the above adverse outcomes occurring. We also looked at discharge disposition, length of stay (LOS), conversion to open, and operative time between groups. Full NSQIP definitions of variables can be found at https://www.facs.org/quality-programs/acs-nsqip.

Statistical analysis

Categorical variables were analyzed using the chi-squared and Fisher's exact test while continuous variables were analyzed using the Mann Whitney U test. A p value < 0.05 was considered significant. Univariate and multivariate analysis were performed to identify risk factors for incidence of a postoperative event and 30-day mortality. Univariate analysis was conducted on all variables. Multivariate analysis was carried out using a logistic regression model expressed as an odds ratio (OR). The open PD group was used as a reference group in the multivariate analysis. Any baseline characteristic or comorbidity listed in Table 1 which approached significance ($p < 0.1$) in any of the univariate analysis across a given characteristic ($p1$, $p2$ or $p3$) were included in these models as additional risk factors. Statistical analysis was performed using STATA software (StataCorp. Released 2016. Stata/SE for Mac, Version 14.2. College Station, TX: IBM Corp.).

Results

For the years 2014 and 2015, a total of 6827 pancreaticoduodenectomies were performed based on our inclusion criteria, with 6336 (92.8%) performed open, 280 (4.1%) attempted laparoscopically and 211 (3.1%) attempted robotically. Table 1 includes the demographics of the three groups, while Table 2 includes outcomes between the three groups. Table 3 shows the pancreas specific intraoperative findings of the groups.

Laparoscopic compared to open

When compared to the open group, the Laparoscopic group had a lower incidence of HTN (46.8% vs 53%, $p = 0.043$), less preoperative weight loss (10% vs 17.5%, $p = 0.001$), less ASA class 4/5 (2.5% vs 6.7%, $p = 0.006$), and less pre-operative jaundice (37.8% vs 46.8%, $p = 0.003$). There was no statistical difference between the remaining patient demographics or comorbidities.

Laparoscopic cases were more likely to require percutaneous drain placement (18.4% vs 13.2%, $p = 0.013$), less likely to have a SSI (3.2% vs 9%, 0.001), and had a longer operative time (421 min vs 354 min, $p \leq 0.001$) when compared to the open group. Patients in the LPD group had a shorter length of stay (Median 7 vs 9 days, $p \leq 0.001$) and were less likely to be discharged to a new facility after their operation (8.1% vs 13%, $p = 0.018$). There was no statistical difference between other postoperative outcomes, including overall morbidity and mortality.

Robotic compared to open

Compared to the open group, the Robotic group included more white patients (91.1% vs 86.2%, $p = 0.043$), more patients with COPD (7.6% vs 4.2%, $p = 0.030$), less disseminated cancer (0.5% vs 4.6%, $p = 0.001$), more contaminated/dirty cases (25.1% vs 15%, $p \leq 0.001$), was performed on less malignant pathology (57.6% vs 77.6%, $p \leq 0.001$), underwent less preoperative radiation (2.4% vs 7%, $p = 0.005$) and underwent less vascular resections (11.7% vs 17.9%, $p = 0.020$).

Robotic procedures, when compared to open, were associated with less pneumonia (1% vs 4.5%, $p = 0.013$), more CVAs (1.4% vs 0.3%, $p = 0.025$), less perioperative bleeding (14.2% vs 20.5%, $p = 0.026$), more readmission (23.2% vs 16.7%, $p = 0.013$) and longer operative time (404 min vs 354 min, $p \leq 0.001$). The RPD group had a shorter median length of stay (Median 8 v 9 days,

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