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Minimally invasive surgical site infection in procedure-targeted ACS NSQIP pancreaticoduodenectomies

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ABSTRACT

Background: Pancreaticoduodenectomy (PD) incurs a surgical site infection rate of up to 18%. Published rates after minimally invasive PD are comparable or superior to open, but data are limited to high-volume, single-institution series. This study aimed to determine national outcomes. We hypothesized nationwide infections would be reduced with a minimally invasive approach.

Materials and methods: Using the newly available pancreatectomy-specific outcomes in National Surgical Quality Improvement Project, data on surgical site infection in PD were extracted from the procedure-targeted participant user file from 2014 to 2015. χ^2 test determined correlation of infection with approach. Linear regression determined correlation of known parameters with infection rate.

Results: Overall infection rate was 24%. Compared with open, laparoscopic rates were lower ($P = 0.001$), but robotic rates were comparable with open. Stenting, longer operative times, and soft gland texture were associated with increased infection rates, whereas larger duct size and drains were associated with decreased rates (all $P < 0.01$).

Conclusions: Laparoscopic PD is associated with decreased surgical site infection on a national level. This represents the first procedure-targeted National Surgical Quality Improvement Project report on this endpoint. Despite greater infection rates than previously reported, these data support previous institutional reports of decreased infection rates with laparoscopic approach.

Introduction

Surgical site infection (SSI) creates a significant morbidity burden on patients and has a profound impact on nationwide health care costs.[1-8] Approximately 1%-3% of all surgical patients will develop an infection after surgery, resulting in a nationwide added $1.6 billion annual cost and over 900,000 hospital days.[1,6,9] Historically, pancreaticoduodenectomy (PD)

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has been associated with a rate of SSI between 5% and 18%.[1,10-12] In the American College of Surgeons National Surgical Quality Improvement Project (ACS NSQIP) database specifically, SSI rates in all pancreatic surgeries have been reported to be 17%.[13,14]

Minimally invasive techniques have been associated with decreased SSI rates in surgeries such as colectomy, gastrectomy, appendectomy, distal pancreatectomy, and ventral hernia repair.[15-20] Before 2011, however, few NSQIP centers performed large numbers of minimally invasive PD (MIPD), making meaningful evaluations of outcomes between approaches difficult in this procedure.[21] Outcomes from MIPD have only been reported from single-institution studies with high-volume experience or meta-analyses of the same. These reports have demonstrated SSI rates to be at least comparable with open approaches.[22-24] Other outcomes, such as blood loss, delayed gastric emptying, and postoperative pancreatic fistula tend to be decreased in MIPD compared with open, although issues of selection bias must be considered.[23,25]

Laparoscopy is currently the most common approach to MIPD worldwide.[26] Compared with open techniques, it has been shown to have comparable or improved SSI rates.[27,28] It also has been demonstrated to have improved pancreatic fistula rates, blood loss, and length of hospital stay—possible contributors to SSI—with equivalent mortality to open approach.[27,29]

Robotic approaches to PD have also been increasingly reported over the past few years, although outcomes are again only available from large-volume centers.[24,30-34] Wound infections, when reported, seem to be comparable with open procedures in these series.[35-38] Blood loss, similarly to laparoscopy, is also decreased in robotic compared with open surgery.[39] While these previous studies suggest that MIPD could be associated with reduced SSI, no studies on a national level have been reported.

Since initiation in 2014 of the procedure-targeted data collection by NSQIP, 6882 PDs have been recorded. Of these procedures, 536 were laparoscopic or hybrid procedures. These new, procedure-targeted results from NSQIP afford a unique opportunity to evaluate outcomes more generalizable to the national population, while still retaining outcomes specific to pancreatic surgery. We hypothesized that nationwide SSI would be reduced in MIPD as compared with the traditional open approach.

Methods

Using the NSQIP database, we examined all PD from January 1, 2014, through December 31, 2015. The database is a deidentified sample of surgeries on adult patients recorded by participating NSQIP sites and therefore was exempt from institutional review board approval. The ACS NSQIP and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

The ACS NSQIP Participant Use Data Files (PUF) for 2014 and 2015 and the Procedure Targeted (PT) PUF for pancreatic procedures performed in the same years were merged based on the case identifier. The PT files include variables that are more specific to the procedure than those included in the base PUF. Some of the additional fields present in the PT for pancreatic procedures are procedure approach (laparoscopic, robotic, and open), the presence of drains or ductal stents, gland texture, and duct diameter, among others. Inclusion criteria for the following analyses were PT case data and open, robotic, or laparoscopic procedures. Hybrid and converted cases, or those without targeted data, were excluded to delineate clearly the differences between approach, such as incision size and procedure length. For this study, SSI included superficial surgical site infection, deep incisional surgical site infection, organ space surgical site infection, and septic shock. Patient age was stratified by decade. Operative time was stratified by quartiles to account for procedure complexity.

SSI rates were correlated to operative approach using Pearson's χ^2 statistic. Linear regression was used to identify the preoperative and intraoperative factors in the PT file, which correlated with SSI. Propensity scores were calculated to adjust as much as possible for known and suspected differences between the patients who underwent laparoscopic or open procedures. A one-to-one match was performed based on the observed differences in procedural populations from the regression model. These factors included operative time, biliary stent, duct diameter, pancreatic gland texture, and the presence of drains. All statistical analyses were performed with Stata (version 14, College Station, TX).

Results

Over the timeframe studied, 296 patients underwent MIPD of the total 6882 PDs evaluated. Of the total procedures, 125 (1.8%) were laparoscopic and 171 (2.5%) robotic. Most patients underwent open procedures ($n = 6346$, 92%), and another 240 patients had procedures converted to open or hybrid procedures. Of the procedures with an MI component (converted/hybrid or wholly MI), 40 (7.5%) were robotic and 155 (29%) laparoscopic. Only 51% of all laparoscopic pancreatectomies were for malignant indications, whereas 63.6% of robotic and 75.2% of open procedures were for malignancy. Chemotherapy was received within 30 d of 3.8% of laparoscopic pancreatectomies, 11.0% of robotic, and 14.8% of open. Radiation therapy was administered to 1.9% of laparoscopic, 1.5% of robotic, and 6.7% of open procedures within 30 d. The overall rate of SSI in the open and MIPD groups was 24.0% ($n = 1573$). In the open group, 24.2% ($n = 1536$) of the patients developed SSI. In the MI groups, SSI rates were 15.2% ($n = 19$) in laparoscopic approach and 21.6% ($n = 37$) in robotic approach. In patients who developed SSI, chemotherapy and radiotherapy rates were comparable between open and laparoscopic procedures (Tables 1 and 2).

Compared with the laparoscopic approach, both robotic and open procedures had higher rates of infection ($P = 0.03$ and 0.001, respectively) (Table 3). SSI were comparable between open and robotic approaches ($P = 0.6$). Therefore, only laparoscopic and open approaches were considered for linear regression and propensity matching.

Open approach ($P = 0.02$), surgery length in the upper two quartiles ($P = 0.03$ and < 0.005), endoscopic stents ($P = 0.01$),