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ORIGINAL ARTICLE

Robotic approach mitigates perioperative morbidity in obese patients following pancreaticoduodenectomy

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Abstract

Introduction: The aim was to evaluate the impact of obesity on perioperative outcomes in patients undergoing robotic pancreaticoduodenectomy (RPD) compared to open pancreaticoduodenectomy (OPD).

Methods: A retrospective review of all pancreaticoduodenectomies from 9/2011 to 4/2015 was performed. Obesity was defined as body mass index (BMI) > 30 kg/m^2.

Results: Of 474 pancreaticoduodenectomies performed: RPD = 213 (45%) and OPD = 261 (55%). A total of 145 (31%) patients were obese (70 RPD, 75 OPD). Obese patients had increased EBL ($p = 0.03$), pancreatic fistula (B&C; $p = 0.077$), and wound infection ($p = 0.068$) compared to the non-obese. For obese patients, RPD had decreased OR time ($p = 0.0003$), EBL ($p < 0.001$), and wound infection ($p = 0.001$) with no difference in Clavien $\geq$3 complications, margins, LOS or 30-day mortality compared with OPD. In multivariate analysis, obesity was the strongest predictor of Clavien $\geq$3 (OR 1.6; $p = 0.041$) and wound infection if BMI > 35 (OR 2.6; $p = 0.03$). The robotic approach was protective of Clavien $\geq$3 (OR 0.6; $p = 0.03$) on univariate analysis and wound infection (OR 0.3; $p < 0.001$) and grade B/C pancreatic fistula (OR 0.34; $p < 0.001$) on multivariate analysis.

Conclusions: Obese patients are at risk for increased postoperative complications regardless of approach. However, the robotic approach mitigates some of the increased complication rate, while preserving other perioperative outcomes.

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Introduction

Obesity is a major health issue affecting over one third of all adults in the United States in 2014. Obesity is on the rise with the rate doubling in the last 25 years.[1] It is a significant national public health problem placing patients at increased risk of coronary artery disease, diabetes, and cancer. Specifically, it has been discovered to be a risk factor for pancreatic ductal adenocarcinoma (PDAC).[2] One study determined that the relative risk of PDAC in obese people is approximately double that of non-obese patients and that this increased risk is present in patients as young as 18 years old.[3] Epidemiologic data has shown that the risk of dying from pancreas cancer is higher in obese patients.[4] With the growing number of obese adults, understanding the perioperative risks of obese patients becomes essential.

Obese patients have long been thought to display a higher risk of perioperative complications following numerous and distinct surgical procedures, notably having an increased risk of surgical site infections.[5–7] However, the data regarding an increased risk of perioperative complications after pancreatic surgery is mixed. Tsai *et al.* report no increased risk of overall complications but an increase rate of pancreatic fistula formation and wound infection

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rate. However, Williams *et al.* report no difference in overall complication rate, pancreatic fistula or superficial wound infection but an increased rate of intra-abdominal infections.[8,9] Finally, a meta-analysis of 17 publications on body mass index (BMI) and pancreatic resection concluded that the risk of pancreatic fistula increased with BMI while other outcomes were similar between obese and non-obese patients.[10] None of the reported studies, however, have examined the impact of minimally invasive surgery on outcomes in obese patients.

With the more expansive role of minimally invasive surgery in areas such as colorectal and gastric surgery, the increased risk of perioperative complications seem to be curtailed in these groups of obese patients. Specifically, the risk of wound infection in patients with colorectal cancer having undergone a minimally invasive procedure is half as much as when it is performed open.[11] This trend is similar for obese patients with gastric cancer.[12] As minimally invasive surgery is applied to pancreatic diseases, similar outcomes might be expected.

Previously published series on minimally invasive pancreaticoduodenectomy provide limited data on outcomes in the obese populations. Additionally, no study has compared perioperative outcomes in obese populations undergoing robotic and open procedures. Based on these data, this study sought to examine the effect of the robotic approach to pancreaticoduodenectomy in obese patients hypothesizing that this minimally invasive approach would decrease perioperative morbidity in this group.

Methods

This was retrospectively reviewed data acquired from prospectively maintained surgical databases and patients' electronic medical records of all patients undergoing pancreaticoduodenectomy (PD) for any pathology between September 2011 and April 2015. Patient cohorts were included into cohorts of obese and non-obese as well as into those having had robotic pancreaticoduodenectomy (RPD) and open pancreaticoduodenectomy (OPD). Intention to treat analysis was performed.

BMI was calculated as weight in kilograms (kg) divided by the height in squared meters (m^2). Obesity was defined according to the National Institute of Health criteria, BMI $\geq$ 30. Morbid obesity was defined as BMI $\geq$ 35.[13] The institutional review board (IRB) of the University of Pittsburgh Medical Center (UPMC) provided approval for this project (IRB #PRO14060325).

All patients were included in this study who underwent RPD or OPD at the flagship UPMC hospitals. This includes cases by 11 surgeons, 10 fellowship trained with expertise in hepato-pancreato-biliary (HPB) surgery. The RPD cases are all after the published learning curve and primarily from 4 surgeons. Primary indication for the surgeons performing RPD to perform an OPD were absence of available robotic block time or possibility of needing a vascular resection with internal jugular conduit.

Definitions set forth by the International Study Group of Pancreatic Surgery (ISGPS) were used for pancreatic fistula (POPF), delayed gastric emptying (DGE), and post-pancreatectomy hemorrhage (PPH).[14–16] Complications were scored according to the Clavien-Dindo classification system.[17,18] The age-adjusted charlson comorbidity index (AA-CCI) was used to determine comorbidity status prior to operation.

Comparisons were performed between the entire obese vs non-obese cohort, as well as direct comparison between the robotic (RPD) obese vs open (OPD) obese sub-groups. Those with normal distribution were analyzed using unpaired *t* test and ANOVA for differences between groups, while the Wilcoxon rank-sum test was used for variables without a normal distribution. Chi-squared test was used for categorical variables. Logistic regression was performed on the entire cohort including approach and obesity as variables within the model. Logistic regression was also performed on the obese cohorts. Univariate and multivariate logistic regression modeling was performed for desired outcomes of pancreatic fistula, wound infection, and Clavien complications. Multivariate analysis was performed in a backward stepwise analysis and presented as odds ratios (OR) with 95% confidence interval (95% CI). All statistical tests were 2 sided and differences were considered significant when $p < 0.05$. Statistical analyses were performed using SAS/STAT statistical software version 9.4 (SAS Institute, Cary, NC) and R version 3.0.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

During the study period, 474 patients had a pancreaticoduodenectomy performed; 145 (30.4%) in obese patients. When comparing demographics and intra-operative variables of obese patients to non-obese patients (Table 1A), obese patients were younger (64.9 years vs 67.1 years, p = 0.048), had less PDAC (45% vs 56%, p = 0.037), and had a higher EBL (400 ml vs 300 ml, p = 0.030) than non-obese patients, respectively. Postoperatively, obese patients demonstrated a trend for a higher rate of grade B/C pancreatic fistula formation compared to the non-obese patients (21% vs 14%, p = 0.077). Also, wound infection rates trended higher in obese patients (32% vs 24%, p = 0.068) compared to non-obese patients.

In the obese cohort, 70 (48.3%) patients underwent RPD, while 75 (51.7%) underwent OPD. There were no differences between any preoperative factors (Table 1A) in the obese RPD compared to obese OPD cohorts. Specifically, there were no differences in the proportion of pancreatic ductal adenocarcinoma (PDAC) in either group. Also the rate of neoadjuvant chemotherapy (27% RPD vs 39% OPD: p = 0.14) and major vascular resection (10% RPD vs 21% OPD: p = 0.06) was not different in these groups. Only 3 (1.4%) RPD were converted to open; 0 (0%) in the obese RPD cohort.

Intra-operative outcomes were significantly different between the robotic and open cohorts of obese patients (Table 1B). The

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