Editorial

Robotic pancreaticoduodenectomy: a safe minimally invasive option

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Pancreatic cancer is the 4th leading cause of death in the United States. Over 50,000 patients will be diagnosed with pancreatic cancer in 2019 (1) but only a small percentage of these patients will be operable candidates. This is due to locally advanced or metastatic cancer at time of diagnosis. For decades, the conventional "open" pancreaticoduodenectomy has been the standard of care for adenocarcinoma in the head of the pancreas in patients deemed operative candidates. Over 20 years ago, laparoscopic pancreaticoduodenectomy was first completed (2); the operation was of excessively long duration and was followed by a protracted hospital stay. Laparoscopic pancreaticoduodenectomy has been slow to gain popularity, mostly due to the technical challenges associated with the biliary and pancreatic reconstructions. Thereby, few surgeons around the world utilized this technique. Approximately 10 years ago, surgeons began to utilize the da Vinci® Robotic Surgical System (Intuitive Surgical, Inc, Sunnyvale, CA, USA) when undertaking pancreaticoduodenectomy (3). The robotic platform decreases much of the operative difficulty encountered during laparoscopic surgery. The robotic platform is advantageous during complex operations providing surgeons with better visualization by means of a 10–15 magnification of the surgical field, 3-dimensional high definition visualization, elimination of hand tremors, and increased precision due to 540° of instrument rotation. The debate in Surgery regarding "open" *vs.* minimally invasive oncologic resections involves many metrics, including morbidity, mortality, lymph node yield, and overall survival, and is ongoing. We believe that laparoscopic complex oncologic operations (e.g., pancreaticoduodenectomy) have limitations because of necessary associated skills and the future of minimally invasive oncologic operations lies in utilization of the robotic platform. Thus, it seems natural to compare "open" pancreaticoduodenectomy and robotic pancreaticoduodenectomy.

The study designed by Wang *et al.* (4) was intended to compare fistula rates between "open" and robotic pancreaticoduodenectomy. Their conclusions go well beyond the primary intent of their study. The data presented by Wang *et al.* (4) shows there is no difference in pancreatic fistula rates, morbidity, mortality, and oncologic outcomes between "open" and robotic pancreaticoduodenectomy. Furthermore, robotic pancreaticoduodenectomy was associated with significantly less estimated blood loss (EBL); this is good. We know that red blood cell transfusions in patients undergoing pancreaticoduodenectomy are associated with increased 90-day mortality, poor oncologic control, and risk of developing major complications (5). It has been our experience that the robotic platform allows us to do "bloodless" operations, even in the setting of superior mesenteric vein/portal confluence tumor effacement. As robotic pancreaticoduodenectomy becomes more widely adopted, improvements in length of stay, post-operative pain, and time to "recovery", including application of adjuvant therapy, will be widely accepted.

Wang *et al.* (4) used propensity score-matching strategy in the methodology of this report, again designed to compare pancreatic fistula rates after "open" *vs.* robotic pancreaticoduodenectomy. Four variables were used in their methodology: pancreas texture, pancreatic duct diameter,

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pancreatic pathology, and blood loss. Comparisons of morbidity, mortality, and oncologic outcomes between "open" and robotic pancreaticoduodenectomy seem to be a reach, though a noble one. Patients chose their method of resection and there are strong socioeconomic influences in their choices. Furthermore, data from some tables seem erroneous, though it may be our inability to understand. For example, in table 1, there are more patients with a firm gland after propensity scoring than before, when all the patients are considered. As well, there are again more patients with negligible fistula risk after propensity scoring? Where did these additional patients come from? As they discussed, their patients' lengths of stay are not consistent with ours in the West. Survival of the same 29 patients increased after propensity score-matching (table 4 *vs.* table 5). Nonetheless, there is much to be learned herein. Much like "open" cholecystectomy when compared to laparoscopic cholecystectomy, the future is robotic pancreaticoduodenectomy and the future is here and now.

Wang *et al.* (4) designed this study to compare pancreatic fistula rates after "open" *vs.* robotic pancreaticoduodenectomy. The fistula rates were near 10% following either approach. This is not outside the rate seen by others. It is not lower than most or more than most. It seems a reasonable rate, though best would be 0%. Is their rate acceptable because of their technique? Hard to know because their technique is not compared to any other. Some results must be accepted for what they are, and we believe this study adds to the growing body of supportive literature on robotic pancreaticoduodenectomy and its salutary nature.

Operations for pancreatic cancer are becoming less invasive with robotic surgery. Despite all "the good news" associated with robotic pancreaticoduodenectomy, there are relatively few surgeons and even fewer institutions that offer robotic pancreaticoduodenectomy; we estimate that much less than one in ten pancreaticoduodenectomies are undertaken robotically. The reason for this is, in part, due to the complexity of the operation and surgeons' unfamiliarity with the robotic platform. Herein there are two learning curves: one for pancreaticoduodenectomy and one for robotic surgery. One particularly applies to younger surgeons and one to older surgeons experienced in HPB surgery. Though application of the robotic platform is relatively infrequent and even with a limited number of institutions undertaking robotic pancreaticoduodenectomy, there has been a 26% increase in robotic pancreatic operations from 2015 to 2017 and this number will only continue to grow.

The authors have demonstrated, and it has been our experience as well, that the benefits seen with robotic pancreaticoduodenectomy come with a cost, and this cost is significant operative time. As surgeons become more comfortable with robotic technology, our focus will have to shift to efficiency with the goal of decreasing operative time. An interesting point was made by the authors when stating their learning curve for robotic pancreaticoduodenectomy was 37 operations. We believe the learning curve is much longer (6) and after 200 robotic pancreaticoduodenectomies we are still learning and improving with each operation. For us, robotic pancreaticoduodenectomy still is of excessive duration and carries much angst. At our institution, we completed 155 robotic pancreaticoduodenectomies from 2012 to 2017, 88% of which were done beginning 2015. Our median operative time was 418 minutes. Analyzing the data further, our operative time for the first cohort consisting of 25 patients was 420 minutes while the last cohort consisting of 30 patients was 404 minutes (7). There is still room for improvement in our operative time and this is after completing over 200 robotic pancreaticoduodenectomies to date.

There is no doubt that robotic surgery will be taking over in a "big" way. Our goal as surgeons is to keep patients safe and offer them the best chance at a meaningful recovery. We believe robotic surgery is the answer, though the journey for most minimally invasive surgery is a journey and not a destination. The challenges that lie ahead of us are many. One of the biggest challenges we will have is training surgeons to do complex oncologic operations robotically, to do them safely, and to do them efficiently. Perhaps the best way to ensure this is by referring these patients to the large volume centers.

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conflicts of interest to declare.

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