Editorial

Laparoendoscopic single-site and robotic distal pancreatectomy

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Distal pancreatectomy (DP) is a standard procedure for neoplastic or inflammatory lesions in the body and tail of the pancreas. With the recent development and improvement of laparoscopic techniques and increasing surgical experience, laparoscopic surgery has been widely performed. Although the laparoscopic pancreatic surgery was introduced later when comparing to other organs, laparoscopic DP is the most widely used because of its acceptable technical feasibility and safety without complex anastomoses or reconstructions. The first report of laparoscopic DP was published by Cuschieri *et al.* (1) in 1996. They reported five cases of laparoscopic DP with splenectomy for chronic pancreatitis. Recent meta-analyses have shown the superiority of laparoscopic DP comparing to open DP in terms of intraoperative blood loss, patient recovery, and hospital stays with comparable morbidity rates (2-4). Although no randomized trial performed in comparing laparoscopic and open DP, laparoscopic DP has been regarded as the gold standard for at least benign and low-grade malignant tumors in comparison with the open procedures. Currently, there are several topics and issues to be clarified the real effectiveness of laparoscopic DP, including spleen preservation or not, application for pancreatic cancer, laparoendoscopic single-site surgery (LESS), and robotic surgery. The article summarizes and focus on the topics of LESS and robotic DP.

Robotic surgery emerged at the end of the last century. One of the most advantages of robotic systems could be the reproduction of the movement of the hand and fingers with seven degrees of freedom just as open surgery. Robotic surgery may have potential benefits to reduce the rate of conversion to laparotomy when comparing to laparoscopic surgery. The first robotic laparoscopic DP was described by Melvin *et al.* (5) in 2003. At present, however, most studies of robotic pancreatic surgery are still limited with single-institution, surgeon case series of small numbers. There have been reported three meta-analyses on the safety of robotic versus laparoscopic DP (6-8). The data revealed that there were no differences between the two techniques in terms of the rate of postoperative pancreatic fistula, morbidity, and conversion to open surgery. Zhou *et al.* (6) reported a meta-analysis of robotic versus laparoscopic DP when they showed significant advantages in intraoperative blood loss, length of hospital-stay, and spleen preservation rate. Gavriilidis *et al.* (7) also reported shorter hospital stay in robotic DP in their meta-analysis, but higher readmission rate. Definitive conclusions on the actual role of robotic DP have not been drawn because there is no randomized trial comparing with robotic and laparoscopic DP.

Recently, to develop further minimally invasive surgery by reducing numbers and sizes of the ports, many experienced laparoscopic surgeons have tried to perform new technique. Potential benefits of the minimization of skin incision include cosmesis, less pain, early recovery, and lower rate of port-related complication. Since the first LESS was attempted at laparoscopic cholecystectomy in 2010, LESS has been successfully and widely applied for many abdominal surgeries (9-11). As most patients with cystic or solid and benign tumors of the pancreas are young females, demand for laparoscopic DP to eradicate the tumor and minimize the cosmetic impact of the surgical wound is increased. However, reports of LESS in DP are rather limited because of its technical difficulties (12-16).

In 2010, Barbaros *et al.* (12) first reported on the laparoscopic transumbilical single-site DP. The patient underwent the procedure successfully in spite of severe fibrosis in the retroperitoneal region caused by a previous left nephrectomy. They showed that even laparoscopic

single-site DP could be performed technically. In the next reported four cases, the procedures were also performed as uneventful, suggesting that laparoscopic single-site DP is feasible and safe in selected patients (13-15). In 2014, Yao *et al.* (16) reported 11 cases with laparoscopic single-site DP. They reported that most laparoscopic single-site DPs were successfully performed with splenic preservation in 6 cases and only one conversion to multi-port DP. One patient developed postoperative pancreatic fistula.

In 2015, Ryan *et al.* (17) reported a retrospective study to compare the results of laparoscopic single-site DP (n=16) and robotic DP (n=18) with splenectomy. There were no differences in patient characteristics [(sex, age, and body mass index (BMI)] in the both groups. Conversion to open surgery, estimated blood loss, postoperative complication and length of stay were similar in the both groups. Time spent in the operating room was significantly longer with the robotic DP (297 *vs.* 190 minutes, P=0.03), although operative duration was no longer (225 *vs*. 190 minutes, P=0.15). In all patients, 79% were undertaken for neoplastic lesions with a mean tumor size of 3.5 cm. R0 resection achieved in all the patients. They concluded that patient outcomes are similar with the two procedures. Taken together, previous studies showed that laparoscopic single-site DP is safe and feasible in selected patients. laparoscopic single-site DP might include the benefit of reduced pain, a more cosmetic incision, and faster recovery.

However, single-site laparoscopic DP is difficult and technically quite demanding. LESS includes considerably technical difficulties, and requires a higher level of operation skills. All instruments are closely packed together. The introduction of camera and several instruments parallel to each other results in a decreased range of motion and in instruments crossing over each other. This decreased freedom of motion increases the technical complexity of the operation and results in a significantly increased learning curve for performing LESS. Therefore, laparoscopic single-site DP is a significantly more challenging procedure than traditional laparoscopic multi-port DP. Laparoscopic single-site DP requires extensive surgeon experiences and skills in laparoscopic surgery, and adequate patient selection may be another most important factor to achieve successful outcome.

To overcome the problem of instrument collision, Intuitive Surgical Inc. developed the Da Vinci Single-Site Surgical Platform, a novel set of single-site instruments and accessories specifically dedicated to single-site robotic surgery in 2010 (18). The platform system allows insertion of a multichannel port and curved robotic instruments through a single 3.5 cm transumbilical incision. The system is enable single-site robotic surgical procedures easier than standard LESS. The main indication for the robotic platform is a cholecystectomy. The system was initially developed and the first Food and Drug Administration approved for this type of surgery. However, with increasing experience with the robotic platform, other abdominal operations of general surgery, as well as urological and gynecological operations have been performed using the system. In 2011, Kroh *et al.* (19) successfully performed 13 consecutive single-site robotic cholecystectomy using the robotic platform without significant complication and demonstrating the feasibility of single-site robotic cholecystectomy. In the same year, Wren and Curet (20) also reported 10 single-site robotic cholecystectomy using the robotic platform with favorable results. Thereafter, many studies were published with its safety and feasibility. Notably, some studies suggested that the system allowed rapid overcoming of the learning curve (21-23). Single-site robotic cholecystectomy could be an alternative minimally invasive cosmetic surgery.

However, single-site surgery with the robotic platform still has technical limitations. As the robotic instruments do not have the endo-wrist function, bipolar coagulation instruments and needle drivers, the use of the robotic platform for complicated general surgery remains challenging due to these limitations. Kim *et al.* (24) reported an interesting case series on robotic single-site plus one port DP. They performed five cases of robotic DP using the Da Vinci Single-Site Surgical Platform with one additional port. Additional robotic 12-mm-port was placed left side of the robotic platform, and robotic 3rd arm was used through this site. Using this site, usual robotic instruments such as, hook, bipolar, vessel sealer, and endo-GIA with endo-wrist function could be used to facilitate effective surgical procedure. They reported that median operation time was 165 min (range, 120–270 min), and median intraoperative estimated blood loss was 5 mL (range, 0–50 mL). One patient underwent spleen preserved DP. One patient converted to conventional multi-port robotic DP due to inter-arm collisions. There was no clinically relevant postoperative pancreatic fistula. Length of hospital stay was median 6 days after surgery (range, 5–8 days). Similar technique has been reported by Bae *et al.* (25) for left-side colorectal cancer in 2016. All 11 consecutive patients were technically successful without conversion to laparoscopic surgery. Although the reported

number of patients was small, this approach may facilitate to expand more minimally invasive surgery with currently available robotic surgical system.

In conclusion, evidence has been increasing with good perioperative outcome in minimally invasive pancreatic surgery. Both LESS and robotic surgery are emerging techniques that have been suggested as a promising and alternative to conventional laparoscopic surgery. Initial experiences have shown to be considered and effective option for pancreatic resection. Further advances in the field of laparoscopic single-site and robotic pancreatic surgery are expected. Prospective randomized trial is warranted to determine whether single-site and robotic DP have any clear advantage over conventional laparoscopic DP.

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