

# Clinical efficacy of total three-dimensional laparoscopic pancreatoduodenectomy

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## Abstract

**Objective** To investigate the feasibility and clinical efficacy of total three-dimensional laparoscopic pancreatoduodenectomy.

**Methods** The clinical data of 28 patients who underwent total three-dimensional laparoscopic pancreatoduodenectomy at the Second Hospital of Hebei Medical University from August 2015 to May 2016 were retrospectively analyzed. The surgical indications and method of performing total three-dimensional laparoscopic pancreatoduodenectomy were similar to those of the patients who underwent two-dimensional laparoscopic pancreatoduodenectomy. All of the patients were followed up via outpatient reviews and telephone interviews through September 2016.

**Results** In all 28 cases, total three-dimensional laparoscopic pancreatoduodenectomy was successfully performed with no conversion to laparotomy, intraoperative complications, or perioperative death. The mean operative time was 406 min (200–520 min) with a mean blood loss of 528 mL (200–1500 mL), a mean number of dissected lymph nodes of 11 (6–16), a mean postoperative anus exhaust time of 4.4 d (2–8 d), and a mean length of stay of 16.9 d (9–23 d). There was a postoperative pancreatic fistula in 4 out of the 28 cases, with 3 cases of grade A and 1 case of grade B. Postoperatively, one patient with early-stage intra-abdominal hemorrhage improved after conservative symptomatic treatment, and two patients with gastroplegia were cured with conservative treatment. No complications occurred in the other patients. All of the cases underwent R0 resection with a negative surgical margin. All of the 28 patients were followed up for 6 to 12 months, with a median follow-up period of 9.2 months. During the follow-up period, there were no postoperative complications related to the procedures and no deaths; tumor recurrence was identified 9 months after the procedure using positron emission computed tomography (PECT) in one patient with pancreatic ductal adenocarcinoma.

**Conclusion** Total three-dimensional laparoscopic pancreatoduodenectomy is safe and feasible for the treatment of periampullary carcinoma, with the advantage of favorable short-term outcomes.

**Key words:** periampullary carcinoma; laparoscopy; pancreatoduodenectomy; three-dimensional

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Since the first case of laparoscopic pancreatoduodenectomy was performed by Gagner<sup>[1]</sup> in 1992, domestic and foreign scholars have carried out a large number of in-depth studies. Up to now, surgeons have been performing laparoscopic pancreatoduodenectomy using advanced endoscopic technology to complete the resection of periampullary carcinomas<sup>[2–3]</sup>. Along with the development of a three-dimensional laparoscopic surgery system, scholars at home and abroad have started to apply this new technology to laparoscopic

pancreatoduodenectomy. The author's institution has performed three-dimensional laparoscopic pancreatoduodenectomy in recent years, mainly for periampullary carcinomas. In this study, the clinical data of 28 patients who underwent total three-dimensional laparoscopic pancreatoduodenectomy for periampullary carcinomas from August 2015 to May 2016 in our department were retrospectively analyzed; the objective was to explore the feasibility and clinical efficacy of the operation.

## Materials and methods

### General information

There were 16 men and 12 women with 28 periampullary neoplasms enrolled; their ages varied from 27 to 72 (mean age, 58.5) years and a mean preoperative bilirubin level of 74.08 mmol/L (4.3–236.47 mmol/L). Eleven of them underwent preoperative biliary drainage. This study was approved by the Ethics Committee of our hospital, and the patients and their relatives signed an informed consent form before surgery.

### Inclusion and exclusion criteria

Inclusive criteria: (1) Duodenal papilla and periampullary carcinoma, distal common bile duct carcinoma, pancreatic cancer, or duodenal carcinoma; (2) Well-functioning vital organs, such as the heart and lungs, which can tolerate a long time under pneumoperitoneum; (3) The preoperative bilirubin level did not exceed 400 mmol/L; (4) No contraindications for surgery. Exclusive criteria: (1) Distant metastasis of the tumor was found before the operation; (2) Great vessels such as the superior mesenteric artery and vein were invaded by the tumor; (3) Cardiopulmonary dysfunction and other contraindications for surgery.

### Operation methods

The procedures were performed with patients supine in the straddled reverse Trendelenburg position under conventional tracheal intubation and general anesthesia. The operations were performed with 5 trocars. The operators' position, establishment of pneumoperitoneum, placement of trocars, and other surgical procedures, were all the same as those used with traditional two-dimensional laparoscopes. A total three-dimensional laparoscopic pancreatoduodenectomy meant the tumor resection, lymph node dissection, mesopancreas excision, and alimentary canal reconstruction (Child procedure) were performed under the three-dimensional laparoscope; a classical mucosal-to-mucosal pancreatojejunostomy was performed with the placement of a supporting tube in the pancreatic duct<sup>[4]</sup>.

### Follow-up

All the patients were followed up via outpatient reviews and telephone interviews. The follow-up period ended in September 2016.

## Results

In all 28 cases, total three-dimensional laparoscopic pancreatoduodenectomy was successfully performed with no conversion to laparotomy. There were no intraoperative complications or perioperative deaths. The mean

operative time was 406 min (200–520 min) with a mean blood loss of 528 mL (200–1500 mL), a mean number of dissected lymph nodes of 11 (6–16), a mean postoperative anus exhaust time of 4.4 d (2–8 d), and a mean length of stay of 16.9 d (9–23 d). According to the definition of pancreatic fistula by the International Study Group on Pancreatic Fistula (ISGPF)<sup>[5]</sup>, there was a postoperative pancreatic fistula in 4 out of the 28 cases, with 3 cases of grade A and 1 case of grade B. Postoperatively, one patient with early-stage intra-abdominal hemorrhage improved after conservative symptomatic treatment; two patients with gastroplegia were cured with conservative treatment. No complications occurred in the other patients.

Postoperative pathological evaluation findings: there was duodenal adenocarcinoma in 10 cases, choledochal adenocarcinoma in 9 cases, ampullary adenocarcinoma in 1 case, pancreatic ductal adenocarcinoma in 5 cases, pancreatic adenocarcinoma in 1 case, duodenal gastrointestinal stromal tumors in 1 case, and chronic inflammation of the pancreatic tissue in 1 cases. All the specimens underwent R0 resection with a negative surgical margin identified under a microscope.

All of the 28 patients were followed up. The follow-up period ranged from 6 to 12 months with a median follow-up time of 9.2 months. During the follow-up period, there were no postoperative complications related to the procedures. A tumor recurrence was found 9 months after the procedure on positron emission computed tomography (PECT) in one patient with pancreatic ductal adenocarcinoma; no patients died.

## Discussion

Birkett<sup>[6]</sup> and his colleagues were the first to report the use of a three-dimensional laparoscopic system in gastrointestinal surgery. The operation was very difficult due to the technological limitations at that time. With increasing advances in development of three-dimensional laparoscopic systems, surgeons have gradually accepted this technology and applied it to hernia repair, proctocolectomy, and hysterectomy, as well as urological, cardiothoracic, and other surgeries, which have achieved excellent results<sup>[7]</sup>. However, the application of a three-dimensional laparoscopic system in pancreatoduodenectomy has been rarely reported.

The advantages of a three-dimensional laparoscopic system include accurate space location and apparent feeling of depth in vision, which makes it more accurate during the isolation of important blood vessels and lymphadenectomy; owing to the outstanding stereoscopic visualization, the grasp of surgical margins or operation distance is more accurate. It is helpful in three-dimensional judgments about the exchange operations of the needle-holding apparatus and knotting when performing

precise anastomoses (such as vascular anastomosis) and alimentary canal reconstruction. These benefits mean the operation is more convenient, thus the surgical mistakes are fewer and the learning curve is diminished, which makes it friendlier to beginners. In addition, costing no more than two-dimensional laparoscopic systems, it helps in the promotion and improvement of laparoscopic technology [8].

After completion of 28 cases of total three-dimensional laparoscopic pancreaticoduodenectomy, we have realized that the surgical procedures and skills as well as the indications and contraindications necessary to be mastered under a three-dimensional laparoscopic system were in accordance with those needed to master a two-dimensional laparoscopic system. However, the total three-dimensional laparoscopic pancreaticoduodenectomy was superior to the total two-dimensional laparoscopic pancreaticoduodenectomy in operative time, blood loss, number of dissected lymph nodes, length of stay, results of radical resections of tumors, and occurrences of complications, with no differences in survival time. However, there has been no prospective randomized trial comparing two to three-dimensional surgery yet.

The technological difficulties of laparoscopic pancreaticoduodenectomy are: (1) The completeness of mesopancreas excision; (2) The completeness of lymph node dissection; (3) Hemostatic technology; 4. Pancreatojejunostomy. The deep position of the uncinate process of the mesopancreas with the superior mesenteric artery and the root of the celiac truncus surrounded results in poor exposure and a difficult operation, which is one of the key reasons that people question the completeness of laparoscopic pancreaticoduodenectomy. A total mesopancreas excision requires the complete removal of the nerves and lymphoid tissues within the right side and 180° of the superior mesenteric artery. The author has experienced the characteristics of a three-dimensional laparoscope, such as apparent feeling of depth in vision, high partial magnification times, and accurate space location. Intraoperatively, the descending part and level part of the duodenum are adequately mobilized to the front of the abdominal aorta, and the superior mesenteric vein and portal vein are suspended by a sling to adequately expose the trunk and root of the superior mesenteric artery. The soft tissue on the right side of the artery is separated along the arterial sheath to further sever the arterial branches one by one until reaching the root of the artery. Then, it is mobilized upward until dissociated from the root of the celiac truncus and comes to the right crura of the diaphragm. Thus, the goal of total mesopancreas excision is achieved.

Complete lymph node dissection is conducive to a better prognosis of patients. With the high spatial resolution of a three-dimensional laparoscope, a strong sense

of the stereo dimensions, and an accurate hold of the tissues, we generally use two approaches from anterior and posterior to dissect the lymph nodes, which can get even better results than an open lymph node dissection. First, the common hepatic artery is found at the upper edge of the pancreas by the anterior approach and taken as an axis to open the arterial sheaths and fully expose the common hepatic artery and proper hepatic artery. Then, the dissection is performed until reaching the hepatic portal, and the gastroduodenal artery and right gastric artery are severed at the same time. Second, the duodenal circle and pancreatic head are raised through the posterior approach to dissect the no. 16th lymph node between the inferior vena cava and abdominal aorta. At the time of mesopancreas excision, the lymphoid tissues at the superior mesenteric artery and the root of the celiac truncus are dissected by the posterior approach until reaching the junction of the anterior approach. The lymphoid tissue is totally removed through the anterior and posterior approaches, which achieves the goal of radical dissection.

Skilled hemostasis and vascular suture technology is one of the key technologies that guarantee the success of laparoscopic pancreaticoduodenectomy. The main reason for converting to laparotomy are the numerous vessels around the pancreas, which lead to poor exposure and can hemorrhage easily with massive blood loss during isolation. Under the three-dimensional laparoscope, the observation of hemorrhagic spots is more precise and the sutures can be more accurate. In particular, during the resection and reconstruction of the superior mesenteric artery and vein invasion, the view on the three-dimensional laparoscope can guarantee the accuracy of needle-puncturing angle, needle distance, and needle margin, which avoids winding and knotting of the sutures and makes the vascular reconstruction faster and more accurate.

Pancreatojejunostomy is the key of a successful laparoscopic pancreaticoduodenectomy. According to the reports in the literature, the incidence of postoperative pancreatic fistula for laparoscopic pancreaticoduodenectomy is 0%–38.95% [9]. Pancreatic fistula often leads to abdominal hemorrhage or upper gastrointestinal hemorrhage with an incidence of 11%–45% [10]. Based on our previous experience, we performed a classical duct-to-mucosal and end-to-side pancreatojejunostomy, with supporting tubes in the pancreatic duct [11].

Under the three-dimensional laparoscope, the pancreas end is observed with a strong sense in stereo dimensions and high partial magnification, which allows us to avoid injuries to the portal vein and splenic artery, and makes it easier to understand the needle distance. We utilize double purse string sutures to achieve continuous suture of the pancreatic duct to the jejunum mucosa and the capsule of the end of the pancreas to the seromuscular layer of jejunum. Under stereo visualization of three-

dimensions, the double purse string sutures are not likely to wind or knot. It is faster, more accurate, and more time-saving when the operator picks the needles, sutures, or knots, and when the assistant helps the operator to adjust the angle of the suture knot or to tighten the suture. The anastomosis is more precise with better results. The incidence of pancreatic fistula was 16.7% and mostly were grade A, for which extubation can be done 3 days after the procedure.

Although the three-dimensional laparoscope possesses these advantages, there are still problems in practice that needed to be solved. A three-dimensional laparoscope of 30° could not change the viewpoint by rotating the section angle of the lens, which made it difficult to expose the posterior anatomic structure when there was a block in the target view. A slight tremor of the holding hand or quick rotation of the lens caused obvious shaking of the visual field along with dizziness, eye exhaustion, blurred vision, nausea, and other symptoms of visual fatigue, which is different from previous reports in the literature, but these symptoms could be gradually relieved and eventually disappeared after practice with the system. In addition, owing to the advantages of the three-dimensional laparoscope in the aspects of stereo space identification and precise operation, as well as shortening the operative time and reducing the intraoperative mistakes to some degree, it had higher requirements for the operators. Therefore, a highly skilled and remarkably cohesive team is required to maximize the advantages of three-dimensional laparoscope.

In conclusion, the safety and feasibility of the application of three-dimensional laparoscopic technology to pancreaticoduodenectomy can be ensured as long as the advantages of three-dimensional laparoscope are maximized and when surgeons learn to overcome its obstacles, and a skilled operation team is established, which

can further develop laparoscopic pancreaticoduodenectomy and make it a conventional choice for treating diseases such as periampullary carcinoma.

### Conflicts of interest

The authors indicated no potential conflicts of interest.

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