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ORIGINAL ARTICLE

Initial experiences in robot-assisted middle pancreatectomy

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Abstract

Objectives: Initial results in robot-assisted middle pancreatectomy (MP) have been encouraging. However, data comparing outcomes of robot-assisted MP with those of open MP are limited. The aim of this study was to compare outcomes in patients undergoing open and robot-assisted MP, respectively.

Methods: Outcomes in an initial experience with seven consecutive patients undergoing robot-assisted MP were compared with those in 36 patients undergoing open MP.

Results: The robot-assisted MP group included five women and two men with a median age of 55 years (range: 30–62 years). Median tumour size, operative time and blood loss were 3.0 cm (range: 0.5–5.0 cm), 210 min (range: 150–330 min) and 200 ml (range: 50–400 ml), respectively. Pancreaticogastrostomy was performed in all patients. No transfusion was given intraoperatively. Pathological examination revealed five serous cystic neoplasms, one mixed-type intraductal papillary mucinous neoplasm and one lipoma. Five patients experienced postoperative pancreatic fistula and one experienced post-pancreatectomy haemorrhage. No operative mortality was noted. Compared with the open MP group, the robot-assisted MP group demonstrated a shorter median length of postoperative gastrointestinal tract recovery [2 days (range: 2–3 days) versus 4 days (range: 2–11 days); $P = 0.001$].

Conclusions: Robot-assisted MP can be performed safely with satisfactory efficacy; patients experienced faster gastrointestinal tract recovery compared with patients undergoing open surgery.

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Introduction

In recent years, there has been growing interest in parenchyma-sparing pancreatic surgeries for benign, borderline or low-grade malignant lesions of the pancreas, especially in young patients with long life expectancies; these surgeries aim to preserve exocrine and endocrine pancreatic function, and facilitate a better quality of life after surgery.[1–5] Middle pancreatectomy (MP), for example, serves as an alternative to extended right or left pancreatic resection for the treatment of benign, borderline or low-grade malignant lesions of the neck or the proximal body of the pancreas.[2,4,5] Since it was first reported by Guillemin and Bessot in 1957,[6] MP has been studied intensively and is now generally accepted as a safe and effective procedure, especially in terms of pancreatic function preservation.[2,4,5]

However, the application of minimally invasive approaches to MP has been disappointing. The first laparoscopic MP was described by Baca and Bokan in 2003,[7] but few centres have adopted this minimally invasive approach. This is mainly because of the technical difficulty associated with this procedure during the reconstruction phase, although various reports have confirmed the safety and feasibility of the technique.[7–12]

The robot-assisted surgical system is an emerging technology which has been designed to overcome the intrinsic limitations of traditional laparoscopic surgery by offering three-dimensional surgical views, the facility for precise and flexible wrist-like movements, lack of tremor, reliable fourth-arm movement and better

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ergonomics for surgeons.[13] In fact, the robotic approach has been shown to be safe and feasible for complex and difficult pancreatic resections, including those that require pancreaticoenteric or vascular reconstruction.[13–17]

Studies comparing the outcomes of robot-assisted and open MP are rare. Therefore, at a time when the number of procedures performed using the robotic approach is increasing, it is of great significance to evaluate whether such an approach offers any advantages over open surgery. The aim of the current study was to compare outcomes in patients undergoing open and robot-assisted MP, respectively.

Materials and methods

The present authors retrospectively reviewed the medical charts of patients who were initially scheduled to undergo robot-assisted MP using the da Vinci® Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA, USA) between March 2010 and July 2011. Data collected and analysed included gender, age, symptoms, pathologic diagnosis, tumour size, operative time, estimated intraoperative blood loss, transfusion rate, conversion rate, length of postoperative gastrointestinal tract recovery, postoperative hospital length of stay (LoS), postoperative pancreatic fistula, morbidity, mortality, pathology and follow-up. Conversion in the robot-assisted group was defined by the inability to terminate the operation using a robotic approach.

To provide a comparative analysis, the authors reviewed the medical charts of patients who underwent open MP between April 2003 and December 2009. A total of 40 patients were identified. Four patients were found to have had invasive malignant tumours on final pathologic examination and were excluded from the present study. A comparison of perioperative clinicopathologic characteristics between the two groups was conducted. The design of this study was approved by the authors' institutional review board.

Pancreatic fistula was defined according to the guidelines of the International Study Group on Pancreatic Fistula.[18] Postpancreatectomy haemorrhage was defined according to the guidelines of the International Study Group of Pancreatic Surgery.[19] Operative time was calculated as the time between skin incision and skin closure in the open surgery group, and as the time between skin incision and skin closure of the last port in the robot-assisted surgery group. Complications were defined as those occurring within 60 days of surgery. Postoperative gastrointestinal tract recovery was defined as the time to first flatus after surgery. Mortality was defined as death within the 60 days post-surgery in or out of hospital. Outpatient records combined with telephone interviews were used for follow-up. The follow-up period was defined as the interval between the day of operation and the day of the last follow-up. Follow-up was updated in May 2012. Exocrine deficiency was defined as either new-onset diabetes or deterioration in the metabolic control of previously diagnosed diabetes. Exocrine deficiency was defined as steatorrhea and weight loss requiring pancreatic enzymes supplementation.

The indication for MP during the study period was a lesion located in the neck or proximal body of the pancreas with no evidence of high-grade malignancy that could not be treated with enucleation. To select candidates for this procedure, computed tomography and ultrasonography were routinely performed. Additionally, magnetic resonance imaging, endoscopic ultrasonography and endoscopic retrograde cholangiopancreatography were used at the discretion of the surgeon. Intraoperative frozen-section examination was conducted as part of the surgical protocol to confirm negative margins and frozen pathology was performed in the event of suspected adenocarcinoma. If negative margins were not achieved, subsequent resections and frozen sections were undertaken to achieve negative margins when possible. Negative resection margins were confirmed pathologically in all patients who underwent MP (open and robotic) in the present study.

In the open surgery group, the proximal pancreatic resection was performed with a stapler, electrocautery or knife according to the surgeon's preference. Then the proximal pancreatic stump was closed with continuous or interrupted stitches without special identification and ligation of the main pancreatic duct. The distal pancreatic stump was reconstructed by pancreaticojejunostomy (duct-to-mucosa or invagination) or pancreaticogastrostomy according to the surgeon's preference. Internal stent drainage was carried out as routine practice.

In the robot-assisted surgery group, all patients were operated using a totally robotic approach. The dissection phase was generally similar to that described in the open surgery group. The remnant pancreas was managed by pancreaticogastrostomy with internal stent drainage without a transgastric approach. All robotic and open procedures were performed by the same surgeons (CP and BS).

The operative technique for robot-assisted MP was first described by Giulianotti *et al.*[14] Modifications were later reported by Addeo *et al.*[16] and Kang *et al.*[20] The technique used for patients in the current study was as follows. Patient positioning and setting of trocars were generally the same as those described by Giulianotti *et al.*[14] Four trocars were placed for access by the robotic arms, and an additional 12-mm trocar was placed for the assistant's access (Fig. 1). The da Vinci® surgical arm cart was then docked. The lesser sac was entered by opening the gastrocolic ligament; the posterior gastric wall was lifted and retracted cranially using the fourth robotic arm, exposing the pancreas. The anterior surface of the portal vein was dissected at the superior edge of the pancreatic body (Fig. 2a). The superior mesenteric vein (SMV) was exposed at the inferior edge of the pancreatic neck. A retropancreatic tunnel was then created under the pancreatic neck by gentle dissection with tangential movements in relation to the vascular axis (Fig. 2b). Upon completion of the tunnel, the pancreatic neck was transected using an endoscopic stapler (Fig. 2c) or an ultrasonic scalpel. Interrupted stitches of polypropylene 4–0 were applied to