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REVIEW

Robotic pancreaticoduodenectomy and distal pancreatectomy: State of the art

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Summary Over recent years, minimally invasive pancreatic resections have increasingly been reported in the literature. Even though pancreatic surgery is still considered a challenge for surgeons due to its technical difficulties and high morbidity, the development and spread of robotic surgery has highlighted a new interest, which has induced a rapid spread of robotic approaches for pancreatic resections. This study presents a systematic review of the literature regarding robotic pancreaticoduodenectomy and distal pancreatectomy in order to assess the safety and feasibility of robotic pancreatic resection.

Introduction

Even if almost 20 years have gone by since the first laparoscopic pancreaticoduodenectomy (PD) performed by Gagner and Pomp [1] and first laparoscopic distal pancreatectomy (DP) performed by Cuschieri [2], pancreatic surgery still represents a challenge for surgeons due to its technical difficulty and high postoperative morbidity (pancreatic fistula, hemorrhage, diabetes) [3—7]. At the beginning of the 1990s, minimally invasive surgery (MIS) has revolutionized surgical practice, increasing the interest in the laparoscopic approach for benign and malignant pathologies. Despite such advances, pancreatic surgery has slowly switched to the robotic approach due to its complexity, extensive dissection, and restoration of bowel continuity. With the development of advanced laparoscopic skills, increased evidence not only demonstrated the safety and feasibility of laparoscopic pancreatic surgery [8], but also pinpoints a benefit in terms of postoperative outcome and yields equivalent oncological results [9]. With the development of robotic surgery, several limitations related to the laparoscopic approach have been overcome. A three-dimensional view and an extended degree of freedom of movement allowed performing even more complex procedures. Particularly, during pancreaticoduodenectomy, restoration of bowel continuity using a pancreaticodigestive anastomosis (pancreaticogastric or pancreaticojejunal), hepaticojejunostomy and gastrojejunostomy was facilitated by robotic approach compared to laparoscopy. The aim of this study was to present a systematic review of robotic pancreaticoduodenectomy (RPD) and distal pancreatectomy (RDP) in order to assess their feasibility and safety.

Materials and methods

In this review, a systematic literature search, restricted to papers in English language, was performed using Medline and PubMed to find studies and articles published between January 1, 1999 and March 30, 2015 focusing on patients who

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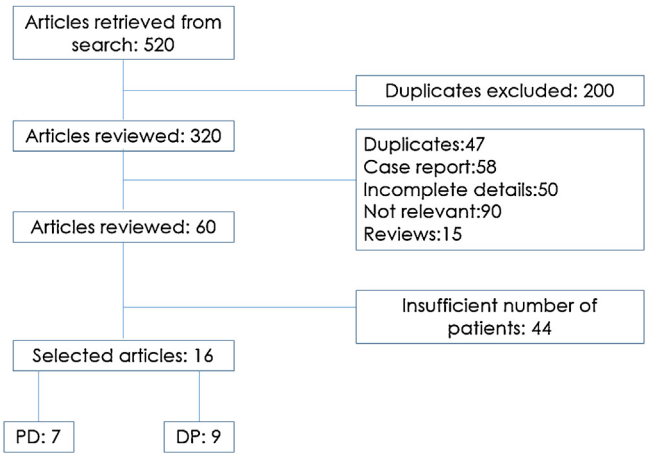

Figure 1. Flowchart of selection of the studies.

underwent RPD and RDP. This review protocol was developed according to PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) guidelines. The keywords used to perform the bibliographic search were: [robotic or robot] and (pancreas or pancreatic or pancreatectomy or pancreaticoduodenectomy or Whipple).

Inclusion and exclusion criteria

Only series reporting more than 20 patients were included in this study in order to exclude selection bias and consider experience of high-volumes centers. In cases of multiple studies originating from the same group, the only one with the largest number of patients was included in the review. Animal studies and clinical studies including less than 20 cases were excluded.

Analysis of data

All relevant data and articles were analyzed and extracted by two independent observers (RM, FS), who consensually decided on the eligibility of articles. Both conventional RDP and spleen-preserving RDP techniques were included. Comparative studies were included in the analysis and data concerning robotic surgery were manually extracted. Studies reporting data on preoperative, intraoperative, postoperative morbidity and mortality, pathological findings, and oncological outcomes were considered for analysis. Minimum and maximum values were noted for each item.

Results

The literature search identified a total of 520 potentially relevant articles, of which 7 were chosen for RPD and 9 for RDP. A flowchart of the studies selection is given in Fig. 1. A total of 432 robotic RPD and 397 RDP were finally analyzed.

Robot-assisted pancreaticoduodenectomy (RPD)

Characteristics of the study included in our review are summarized in Table 1. Seven studies were included in the analysis; 3 were retrospective and 4 were prospective. Three studies were comparative between different techniques, and data were extrapolated and included in the present study.

We collected 432 RPD, and only four papers gave the data allowing to estimate the rate of robotic RPD among all PD performed in the same period: this rate ranged from 15% to 53%. This heterogeneity depended either on the selection criteria of patients or on the experience of the team. Most of teams considered tumor size exceeding 10 cm, the need for vascular resection, and the invasion of adjacent organ as contraindication for robotic surgery. Anyway, with an increasing experience and development of learning curve, performance of vascular resection could be considered as an indication for RPD, as demonstrated by Boone et al. [10]. Operative time ranged from 410 to 491 minutes. Malignant diseases were present in 47 to 83% of patients and the most common malignant tumors were pancreatic and periampullar adenocarcinoma. The rate of conversion ranged from 0 to 18%, the main causes of conversion being difficult dissection and bleeding. Blood loss ranged from 100 to 634 mL. The rate of postoperative complications ranged from 29 to 68% of patients, with 6% to 38% of postoperative pancreatic fistulas, including a majority of grade A fistula according to the ISGPF classification [4]. Most of groups performed a pancreaticojejunostomy to restore the pancreaticodigestive continuity, except Giulianotti et al. [11] who performed pancreaticogastrostomy. Mortality rate ranged from 0% to 7%. Median length of postoperative stay ranged from 9 to 23 days. Rate of readmissions was given in very few studies [12,13] and ranged from 25% to 29%. A R0 resection was achieved in 73% to 100% of patients, with a median number of harvested lymph nodes ranging from 13 to 32.

Comparative studies of robotic and open PD

Four studies included in this review compared open and robotic PD [12—15]. In the study by Chen et al. [12], 33% (60 cases) of RPD were compared to 120 open PD. In this experience, RPD has a longer operative time but decreasing with experience. RPD was associated with less blood loss and a better postoperative course including a shorter hospital stay and a faster return to normal activity. In a comparative study from Giulianotti's group, Buchs et al. [16] analyzed 83 consecutive PD including 39 (47%) open PD and 44 (53%) RPD; in this experience, RPD allowed a lower operative time, a reduced blood loss and a higher number of harvested lymph nodes. Chalikonda et al. [14] analyzed in a case-matched comparison 30 RPD and 30 open PD, demonstrating a longer operative time but a shorter hospital stay in RPD. Bao et al. [15] compared 28 (50%) RPD with 28 (50%) open PD, and concluded that RPD was associated with an increased operative time and fewer lymph node harvested. Lastly, the study from Lai et al. [13], compared 20 (23%) RPD to 67 (77%) open PD and reported a longer operative time but a reduced blood loss and shorter hospital stay after RPD.

Robotic distal pancreatectomy (RDP)

Characteristics of the study included in our review are summarized in Table 2 [9,11,17—23]. Nine studies were included in the analysis, including 6 retrospective and 3 prospective. Four studies [18,20,21,23] were comparative studies between different techniques, and data were extracted to be included in the present study.

We analyzed 397 RDP, performed for malignancy in 23% to 77% of patients according to the study. Most frequent malignancies were ductal adenocarcinoma, neuroendocrine tumor and pancreatic metastasis. Most of teams considered size of lesion exceeding 10 cm and invasion of adjacent