Original Article

Robotic-assisted versus open left pancreatectomy for cystic tumours: A single-centre experience

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Abstract

Background: Cystic pancreatic lesions (CPLs) are being identified increasingly, and some benefit from surgical treatment. With the increasing use of robotic-assisted surgery (RAS) for neoplasms of the pancreas, the aim of the present comparative study is to establish whether the RAS offered any advantages over conventional open surgery (OS) in the management of CPLs.

Patients and Methods: Twenty-seven out of 37 robot-assisted left-sided pancreatectomy (LSP) performed between January 2010 and April 2017 were carried out for CPLs. The surgical outcome and histopathology were compared retrospectively with a control group of 27 patients who had undergone open LSP for CPLs, selected using a one-to-one case-matched methodology (OS-Group) from the prospectively collected institutional database.

Results: The spleen was preserved in a significantly higher percentage of patients in the RAS-group (63% vs. 33.3%, $P < 0.05$). There was no difference in the post-operative course (pancreatic fistula and morbidity) between the two groups. The median post-operative hospital stay was significantly shorter in the RAS-group: 8 days (range 3–25) versus 12 days (range 7–26) in the OS-group ($P < 0.01$). No conversion to open approach was reported in the RAS-group.

Conclusions: Robotically assisted LSP is a safe and effective procedure. It is accompanied by a significantly higher spleen preservation rate compared to the open approach. In addition, because of the reduced trauma, RAS incurred a shorter post-operative hospital stay and faster return to full recovery, particularly important in patients undergoing surgery for relative indications. However, these benefits of RAS for LSP require confirmation by prospective randomised controlled studies.

Keywords: Pancreatic cystic lesions, robotic left side pancreatectomy, spleen-preservation

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INTRODUCTION

With the widespread use of high-resolution imaging, cystic pancreatic lesions (CPLs) are diagnosed with increasing frequency. The term CPLs is used to describe a heterogeneous group, some exhibiting malignant potential.[1] CPLs, according to the WHO classification, involve four main tumour types are as follows: mucinous cystic neoplasms (MCNs), serous cystic neoplasms (SCNs), intraductal papillary mucinous neoplasms (IPMNs) and solid pseudopapillary neoplasm (SPN).[2] Ultrasound (US) examination, computed tomography (CT), magnetic resonance imaging (MRI) and endoscopic US (EUS) with or without fine-needle aspiration (FNA), are used in the assessment of CPLs to establish the diagnosis and outline the appropriate management in the individual patient.[1,3] These lesions are often discovered incidentally during routine investigations of unrelated disorders, and their management may be difficult because often the distinction between MCN, SCN, SPN and IPMN may prove difficult. According to the new European evidence-based guidelines for CPLs, there are three management options as follows: (i) absolute or (ii) relative indications for surgery and (iii) indications for radiological and clinical follow-up.[4] The relative indications are the most difficult because management is contingent not only on clinical factors, for example, age, comorbidities and patient's surgical risk but also on the patient's preference.[4]

CPLs located in the body/tail of pancreas can benefit from parenchymal-sparing resection or spleen-preserving left-sided pancreatectomy (LSP) with laparoscopic surgical approach increasingly considered an appropriate surgical option.[5] On the other hand, laparoscopic LSP remains a challenging operation, with a steep learning curve, high enforced splenectomy and conversion rates, even when performed in high-volume centres.[6] For these reasons, open LSP is still considered the first choice in some centres. The advent of the robotically assisted surgery (RAS) with the da Vinci surgical system may, by facilitating the execution of LSP, reverse the situation. The aim of this study is to address this question by comparing the RAS against open surgery (OS) in the management of left-sided CPLs.

PATIENTS AND METHODS

From January 2010 to April 2017, we performed 37 RAS-LSP, of which 27 had pre-operative diagnosis of CPLs (RAS group). Since January 2010, all patients with CPL of body/tail of the pancreas with surgical indication were operated with robotic assistance. Prospectively, collected data of the RAS group were analysed retrospectively and compared with a control group of 27 patients who underwent (OS group) for the same indication, from January 2006 to December 2009. The OS-group was obtained from the large pool of patients available in the prospectively collected institutional database, using a one-to-one case-matched methodology with the Student's *t*-test, where each patient undergoing RAS was matched with a patient undergoing OS, using the following criteria as follows: pre-operative diagnosis of CPL, location (body/tail) and size of CPL, age, body mass index, the American Society of Anesthesiologists score, previous abdominal surgery and comorbidity.

The pre-operative workup included abdominal ultrasonography, abdomen CT scan and/or MRI, the location and the pre-operative diagnosis of CPLs. In compliance with the European Expert Statement on the management of CPLs, we did not perform routine EUS with FNA routinely to differential the types of CPLs.[7,8] The indication for surgery was based on the guidelines of the European Experts Consensus Statement on CPLs adopted since 2013.[7] Before then, the unit managed CPLs on the Tanaka International Guidelines.[1]

Spleen-preserving surgery was offered to all patients with CPLs in both groups. The need for splenectomy was decided intraoperatively on a case by case basis or for technical reasons. Operative data included operative time, spleen preservation, stapler versus suture closure of pancreatic stump, blood loss, intraoperative complications and conversion to laparoscopic or open surgical approach in the RAS-group.

Postoperatively, the data collected from the two groups included the length of hospital stay (LOS), post-operative morbidity using the Clavien-Dindo Classification[9] and mortality. Specifically, the complications recorded were intra-abdominal fluid collections, surgical site infections, pulmonary or urinary tract infections, post-operative pancreatic fistula (POPF), bowel obstruction, splenic or portal vein thrombosis and 90-day hospital readmissions. POPF was defined and classified using the 2016-Revised International Study Group on Pancreatic Surgery classification (ISGPSC).[10] Pathological data related to the histological diagnosis of pancreatic lesion, number of harvested lymph nodes and size of pancreatic lesion were collected.

The study was approved by Institutional Review Board. All patients received an extensive explanation of the procedure and provided informed consent.

Statistical analysis

For the data analysis, Chi-square test was used to define associations between categorical factors and surgical groups. Continuous variables with normal distribution are expressed as mean ± standard deviation and compared using Student's *t*-test; with statistical significance being set at $P < 0.05$. Variables with an abnormal distribution are expressed as median and compared using the Wilcoxon test. The statistical analysis was performed using SPSS (Statistical Production and Service Solution for Windows, SPSS Inc., Chicago, IL, USA).

RESULTS

Details of patients' characteristics in the two groups and the pre-operative diagnosis are summarised in Table 1. The indication for surgical operation in the RAS-group was based on a pre-operative diagnosis of mucinous cystadenoma in 13/27 patients (48%), branch-duct IPMN with high-risk stigmata or with diameter greater than the threshold value in 5/27 patients (19%) and oligocystic lesion with high risk features in which the pre-operative assessment did not allow distinction between MCN and IPMN in 9/27 patients (33%). In the OS-group, surgery was performed in patients with a pre-operative diagnosis of mucinous cystadenoma in 16/27 patients (59%), branch-duct IPMN with high-risk stigmata or with diameter >3 cm in 3/27 patients (11%) and oligocystic lesion with high risk features in which the pre-operative assessment did not allow distinction between MCN and IPMN in 8/27 (30%).

The perioperative data are shown in Table 2. The mean operative time of RAS-group was 246 ± 92 min (range 110–495) versus 268 ± 69 min (range 135–415) of OS-group ($P = 0.32$). The spleen-preservation rate was significantly higher in the RAS-group, with as a spleen-preserving left pancreatectomy being performed in 17/27 patients (63%) versus 9/27 patients (33%) in the OS-group, $P < 0.05$. There was no conversion to direct manual laparoscopic or OS in the RAS-group. In the RAS-group, the pancreas was stapler transected in 19/27 cases (73%) and transected with monopolar scissors with suture close of residual pancreas in 8/27 cases (27%), whereas in the OS-group, the residual pancreas was closed with sutures in all patients. On the revised-ISGPSC, 3/27 patients (11%) developed grade B fistula in both groups. In the RAS-group, one patient needed emergency angiographic embolisation for erosive bleeding from the adrenal gland on 28th post-operative day, while two patients with grade B POPF required percutaneous drainage of intra-abdominal peripancreatic collections in each group. Medical complications occurred in two patients in the RAS-group (7%) (both Grade II on the Clavien-Dindo Classification) and in three patients in the OS-group (11%) (one Grade I and 2 Grade II). Diabetes mellitus developed in 19% in both groups. No reoperation was required in the RAS-group and one patient in the OS-group needed emergency re-operation (splenectomy) on the 2nd post-operative day for bleeding from the spleen. There were no in-hospital deaths and the median

Table 1: Patients characteristics and pre-operative diagnosis

Parameter	RAS-group	OS-group	*P*
Mean age, years (range)	58.7±13.7 (32–78)	65.3±12.9 (34–78)	0.07
Male: Female (%)	4:21 (16:84)	13:12 (52:48)	<0.05
Mean BMI, kg/m² (range)	25.2±4.5 (14.9–37)	23.9±3.7 (17.9–31.3)	0.24
ASA score, *n* (%)			
ASA I	1 (4)	0	0.31
ASA II	11 (44)	9 (36)	0.57
ASA III	12 (48)	14 (56)	0.59
ASA IV	1 (4)	2 (8)	0.55
Previous abdominal surgery, *n* (%)	12 (48)	14 (58)	0.59
Co-morbidity, *n* (%)			
Diabetes	4 (16)	3 (12)	0.72
Cardiopulmonary disease	14 (56)	16 (64)	0.58
Pre-operative diagnosis			
Mucinous cystadenoma, *n* (%)	13 (48.1)	16 (59.3)	0.41
Brach-duct IPMN, *n* (%)	5 (18.5)	3 (11.1)	0.44
Oligocystic lesions with high risk features of uncertain aetiology, *n* (%)	9 (33.3)	8 (29.6)	0.84

BMI: Body mass index, ASA: American Society of Anesthesiologists, OS: Open surgery, IPMN: Intraductal papillary mucinous neoplasms, RAS: Robotic-assisted surgery

Table 2: Perioperative data

	RAS-group	OS-group	*P*
Mean operative time, min (range)	245.6±92.4 (110–495)	267.8±69.0 (135–415)	0.32
Spleen preserving, *n* (%)	17 (63)	9 (33.3)	<0.05
Conversion to laparoscopic/open approach, *n* (%)	0		
Intraoperative complications, *n* (%)	0	0	1
Estimate blood loss, ml (range)	179 (100–250)	204 (100–300)	0.05
Median hospital stay, days (range)	8 (3–25)	12 (7–26)	<0.01
2016 ISGPS POPF, *n* (%)	3 (11.1)	3 (11.1)	1
Biochemical leak	7 (25.9)	8 (29.6)	0.76
Grade B POPF	3 (11.1)	3 (11.1)	1
Grade C POPF	0	0	1
Intra-abdominal collection, *n* (%)	8 (29.6)	5 (18.5)	0.34
Medical complications, *n* (%)	2 (7.4)	3 (11.1)	0.64
Clavien-Dindo Grade I	0	1 (3.7)	0.31
Clavien-Dindo Grade II	2 (7.4)	2 (7.4)	1
Post-operative mellitus diabetes, *n* (%)	5 (18.5)	5 (18.5)	1
Reoperation, *n* (%)	0	1 (3.7)	0.31
Mortality, *n* (%)	0	0	1

POPF: Post-operative pancreatic fistula, ISGPS: International Study Group on Pancreatic Surgery, OS: Open surgery, RAS: Robotic-assisted surgery

post-operative LOS was significantly shorter in the RAS-group: 8 days (range 3–25) versus 12 days (range 7–26) in the OS-group ($P < 0.01$).

Histopathological data are summarised in Table 3.

DISCUSSION

CPLs are increasingly diagnosed because of the significant advances in diagnostic imaging modalities in recent decades.[4] The majority of CPLs need surveillance with only a minority needing surgical resection[4,11] and not infrequently, some CPLs exhibit morphological mixed features to the extent that definite or reliable diagnostic differentiation between lesions with or without risk of malignancy is not possible, leading to potential under or overtreatment.[12]

As the new Evidence-Based European Guidelines clearly express the need for the surgeon to consider patient's specific factors in decisions based on relative indications for surgery, one of which being the patient preferences,[4] advice on a less invasive option becomes an important component of the clinical management.

Since the description of the first laparoscopic LSP by Cuschieri in 1994,[13] this approach has gained popularity because of the advantages of the minimally invasive approach. Nevertheless, laparoscopic LSP remains a challenging operation with a steep proficiency-gain curve and diminished degrees of freedom (DoF) imposing technical difficulty in the dissection of the pancreas from splenic vessels with the risk of uncontrolled bleeding necessitating urgent conversion to laparotomy.[14] Because of these technical difficulties, in most hospitals, LSP is still performed with the conventional open surgical approach.

Table 3: Pathological data

	RAS group	OS group	*P*
Pathological diagnosis, *n* (%)			
Mucinous cystadenoma	6 (22.2)	6 (22.2)	1
IPMN	5 (18.5)	4 (14.8)	0.72
Serous cystadenoma	5 (18.5)	2 (7.4)	0.22
Pseudocyst	2 (7.4)	3 (11.1)	0.64
Acinar cell cystadenoma	2 (7.4)	0	0.15
Serous microcystic cystadenoma	1 (3.7)	9 (33.3)	<0.01
Serous oligocystic cystadenoma	1 (3.7)	2 (7.4)	0.55
Lymphoepithelial cyst	1 (3.7)	0	0.31
Lymphangioma cystic	0	1 (4)	0.31
Malignant diagnosis	4 (14.8)	0	0.038
Mucinous cystadenocarcinoma	1 (3.7)	0	0.31
Mucogelatinous adenocarcinoma	1 (3.7)	0	0.31
Neuroendocrine tumour	1 (3.7)	0	0.31
Adenocarcinoma and neuroendocrine tumour	1 (3.7)	0	0.31
Mean lymph node harvest, *n* (range)	14.2±18.6 (0–85)	14.8±10.0 (1–39)	0.89
Mean tumour size, cm (range)	4.3±1.8 (2–10)	4.4±2.1 (1.2–10)	0.81

IPMN: Intra-ductal papillary mucinous neoplasms, OS: Open surgery, RAS: Robotic-assisted surgery

The added features of the da Vinci System, such as EndoWrist with increased DoF, the motion scaling and abolition of physiological tremor, enable precise dissection and suturing to 'superhuman' level, further enhanced by the high definition three-dimensional imaging. With the RAS approach, all the difficult tasks of the LSP, for example, dissection of pancreatic body and tail from splenic vessels, suturing, control of bleeding, completion of retropancreatic tunnel and suturing the pancreatic stump with the closure of Wirsung duct can be performed more easily with respect to the laparoscopic approach. The results of the present study, demonstrate clear potential benefits without compromising patients' safety. These include higher spleen preservation rate, significantly reduced hospital stay and shorter operative time.[15]

Various authors reported a longer operative time with the laparoscopic compared to the OS approach, attributed to the increased technical difficulties due to the reduced DoF.[6,16,17] In this respect, the shorter operative time (albeit not significant) by RAS compared to the OS-group despite the significantly higher spleen preservation rate cannot be ignored, especially in view of reports of significantly reduced operative times, when the procedure is performed with the RAS approach compared to laparoscopic approach.[18,19]

Another important clinical outcome documented by the present study is the absence of conversions to OS in the RAS-group, also in accordance with other reports of robotic LSP.[18,20]

All these observations are relevant to the management of CPLs in several aspects, namely reduction of complications and LOS in lesions which turn out to be benign on histology and oncological safety for both preoperatively suspicious and unexpected malignant disease encountered at operation.

Our results suggest also a clear improvement of the imaging modalities over time, with few misdiagnosed MCN versus SCN, and more malignancies in the RAS-group compared to the OS-group carried out several years previously. However, in the more recent RAS-group, we still had 7 cases (26%) of serous cystadenoma diagnosed histologically after surgery. These data do not differ significantly from those reported in literature. Thus, even

with the most recent imaging techniques, a large proportion of SCN cannot be definitively diagnosed before operation, particularly those with atypical imaging findings.[2,21] In fact, the accuracy for identifying the specific type of PCLs is between 40% and 95% for MRI/MRCP and between 40% and 81% for CT[4] and the ability to accurately distinguish SCN ranged from 23% to 82%.[22]

The increased cost of RAS has prevented the more widespread adoption of the robotic technology. However, there is emerging evidence that with experience there is a significant optimisation of RAS with depreciation of fixed costs. Moreover, the use of da Vinci platform is associated with the shorter operative time and LOS of RAS-LSP could result in mitigation of this issue.[23]

A possible limitation of the present study is related to the retrospective nature and the fact that the RAS and the OS groups are not contemporaneous, thus raising the issue of time bias as a potentially significant concern. However, the similar patients' characteristics and the treatment offered by the same surgical group should balance this possible bias.

CONCLUSIONS

The results of the present study indicate that RAS-LSP is a safe and effective procedure, with good clinical outcomes, comparable in all respects to traditional OS. Spleen preservation rate is significantly increased by the RAS. Moreover, because of the reduced trauma, RAS is associated to a shorter post-operative course and faster return to health particularly important in patients with CPLs, in increasing their consent for surgery in instances of relative indications. However, these benefits of RAS require confirmation by prospective randomised controlled studies.

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Conflicts of interest

There are no conflicts of interest.

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