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CASE REPORT

Robotic resection of the uncinate process of the pancreas

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Abstract
Since the development of the robotic platform, the number of robotic-assisted surgeries has significantly increased. Robotic surgery has gained growing acceptance in recent years, expanding to pancreatic resection. Here, we report a total robotic resection of the uncinate process of the pancreas performed in a patient with a cystic neuroendocrine tumor. To our knowledge, this is the first report of a robotic resection of the uncinate process of the pancreas. A 46-year-old man with no specific medical history was diagnosed with a neuroendocrine tumor after undergoing routine imaging. Biopsy guided by echoendoscopy revealed a well-differentiated neuroendocrine tumor. We decided to perform a robotic resection of the uncinate process of the pancreas after obtaining informed consent for the procedure. According to preoperative echoendoscopy and magnetic resonance imaging, there was a safe margin between the neoplasm and the main pancreatic duct. The technique uses five ports. The duodenum is fully mobilized, and Kocher maneuver is carefully performed. The uncinate process of the pancreas is then identified. The resection of the uncinate process begins with the division of small arterial branches from the inferior pancreaticoduodenal artery in its inferior portion, followed by control of venous tributaries to the superior mesenteric vein. Intraoperative localization of the ampulla of Vater is performed using indocyanine green enhanced fluorescence, thus defining the superior margin of the uncinate process. The pancreatic division is made about 5 mm below its upper margin for safety. Surgical specimen is then retrieved through the umbilical port inside a plastic bag. The raw pancreatic area is covered with hemostatic tissue and drained. The total operation time was 215 min. The docking time was 8 min and console time was 180 min. Blood loss was minimum, estimated at less than 50 mL. The postoperative period was uneventful, except for hyperamylasemia in the drain fluid. The patient was discharged on the 3rd postoperative day. The final pathological report confirmed well-differentiated pancreatic neuroendocrine tumor. Robotic resection of the uncinate process of the pancreas is safe and feasible, providing parenchymal conservation in a minimally invasive setting. Robotic resection should be considered for patients suffering from low-grade pancreatic neoplasms located in this part of the pancreas.

Keywords Pancreas · Uncinate process · Robotic surgery · Neuroendocrine tumor · Parenchymal sparing

Introduction

Since the development of the robotic platform, the number of robotic-assisted surgeries has significantly increased. Robotic surgery has gained growing acceptance in recent years, expanding to pancreatic resection. Robotic distal pancreatectomy and pancreatoduodenectomy have been described and are considered feasible and safe [1, 2]. However, parenchymal-sparing procedures, such as central pancreatectomy and isolate resection of the uncinate process of the pancreas, are rarely performed using minimally invasive techniques [3, 4].

We report a total robotic resection of the uncinate process of the pancreas performed in a 46-year-old man with a cystic neuroendocrine tumor. To our knowledge, this is the first report of a robotic resection of the uncinate process of the pancreas.

Case report

A 46-year-old man with no specific medical history was diagnosed with a neuroendocrine tumor after undergoing a routine abdominal ultrasound. Magnetic resonance

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imaging (MRI) disclosed a 1.6 cm cystic tumor in the uncinate process of the pancreas. He was initially diagnosed as intraductal papillary mucinous neoplasms (IPMN) and was being followed up with regular abdominal imaging for 2 years. After a 3-year period, MRI showed a cystic tumor with a significant increase in size to 2.2 cm and heterogeneous aspect (Fig. 1). Based on these new findings, the patient underwent echoendoscopy with a biopsy that revealed a well-differentiated neuroendocrine tumor. Octreoscan confirmed a solitary neuroendocrine pancreatic tumor with no distant metastases. Laboratory tests and physical examination results were normal. According to preoperative echoendoscopy and MRI, there was a safe margin (8 mm) between the neoplasm and the main pancreatic duct (Fig. 1). We decided to perform a robotic resection of the uncinate process of the pancreas after obtaining informed consent for the procedure.

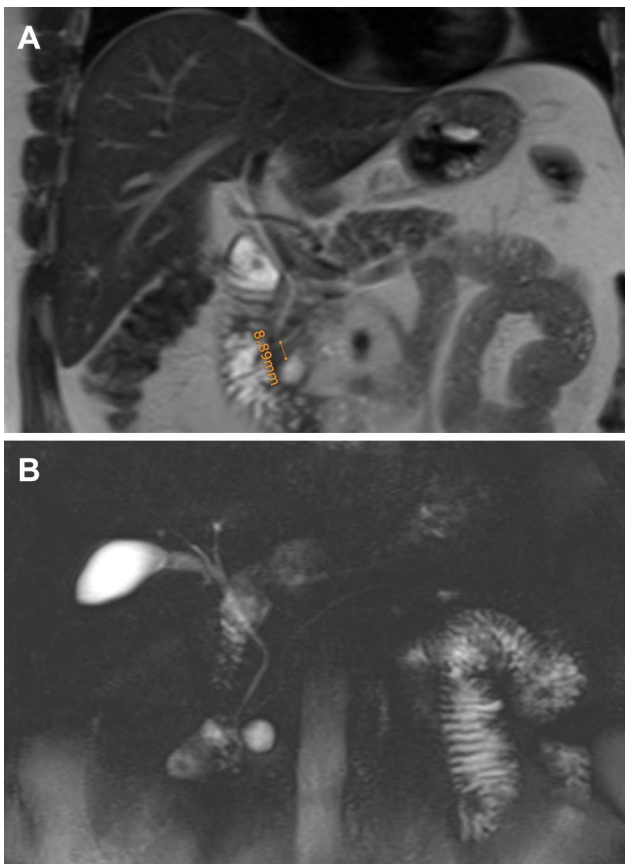

Fig. 1 Magnetic resonance imaging. **a** Coronal view. Cystic NET is seen at approximately 8 mm from the main pancreatic duct. **b** MR Cholangio-pancreatography shows the cystic tumor in the uncinate process of the pancreas

Surgical procedure

The technique uses five ports (Fig. 2). The first 12-mm trocar is inserted into the supraumbilical area using the open method, and a pneumoperitoneum is created at 12 mmHg pressure. A dual lens scope is introduced through this trocar, and four more trocars are inserted under direct visualization. Two 8-mm trocars are inserted on the patient's right side, and one 8-mm trocar is placed on the left side of the patient. An additional 12-mm trocar is placed for bedside surgeon assistance. After docking the robotic system, Cadiere forceps (Intuitive Surgical Inc., Sunnyvale, CA, USA) are inserted through the 3rd robot arm, bipolar grasper forceps (Intuitive Surgical Inc., Sunnyvale, CA, USA) on the 2nd robot arm, and a pair of ultrasonic coagulating shears (Harmonic scalpel, Ethicon Endosurgery Inc., Cincinnati, OH, USA) are inserted through the 1st robot arm. The plane between the right colon and the duodenum is dissected, and the right colon is taken down to expose the duodenum using ultrasonic coagulating shears. The duodenum is then fully mobilized using upward traction and division of ligaments. The Kocher maneuver was carefully performed so not to damage the duodenum wall. The uncinate process of the pancreas is then identified. The uncinate process is limited inferiorly by the inferior pancreaticoduodenal arterial (IPA) arcade that must be preserved to assure duodenal perfusion. On the left margin runs the superior mesenteric vein, which receives some venous tributaries from the uncinate process. The right border is the duodenum and IPA arcade,

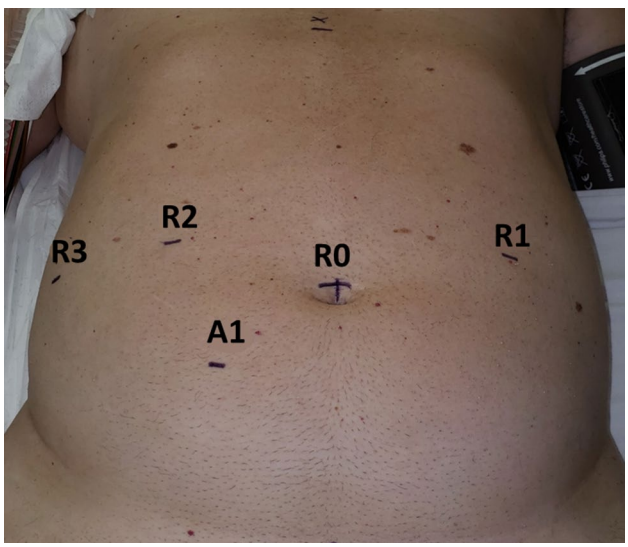

Fig. 2 Port placement. R0 camera port, R1 1st robot arm port: Harmonic Curved Shears, R2 2nd robot arm port: Bipolar Forceps, R3 3rd robot arm port: Cadiere Forceps, A1 assistant port

while superiorly the limit is the main pancreatic duct that must be absolutely preserved.

The resection of the uncinate process begins with the division of small arterial branches from IPA in its inferior portion, followed by control of venous tributaries to the superior mesenteric vein. These small vessels are controlled by either bipolar forceps or ultrasonic energy. The dissection progresses along the right margin close to the duodenum arterial arcade. Intraoperative localization of the ampulla of Vater is performed using indocyanine green enhanced fluorescence (Fig. 3), thus defining the superior margin of the uncinate process (Fig. 4a). The resection progresses using a combination of harmonic shears and bipolar energy. The pancreatic division is made about 5 mm below its upper margin for safety. Resection of the uncinate process of the pancreas is completed (Fig. 4). Temporary hemostasis is done with the application of gauze. The surgical specimen is retrieved through the umbilical port inside a plastic bag. The raw pancreatic area is then covered with an absorbable hemostat and drained.

Results

The total operation time was 215 min. The docking time was 8 min and the console time was 180 min. Blood loss was minimum, estimated in less than 50 mL. The postoperative period was uneventful, except for hyperamylasemia in the drain fluid. The patient was discharged on the 3rd postoperative day. The final pathological report confirmed well-differentiated pancreatic neuroendocrine tumor. The drain was removed 2 weeks after the procedure.

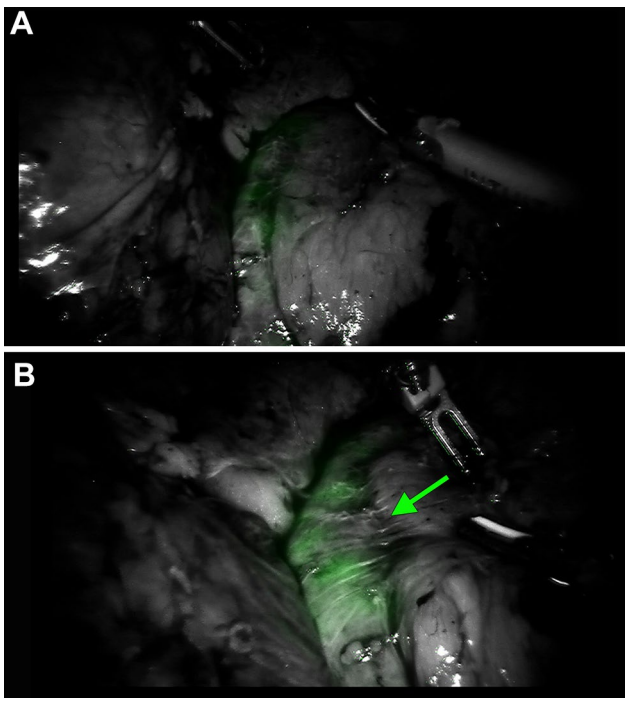

Fig. 3 Intraoperative view. **a** Indocyanine green enhanced fluorescence. **b** Intraoperative localization of the ampulla of Vater (green arrow)

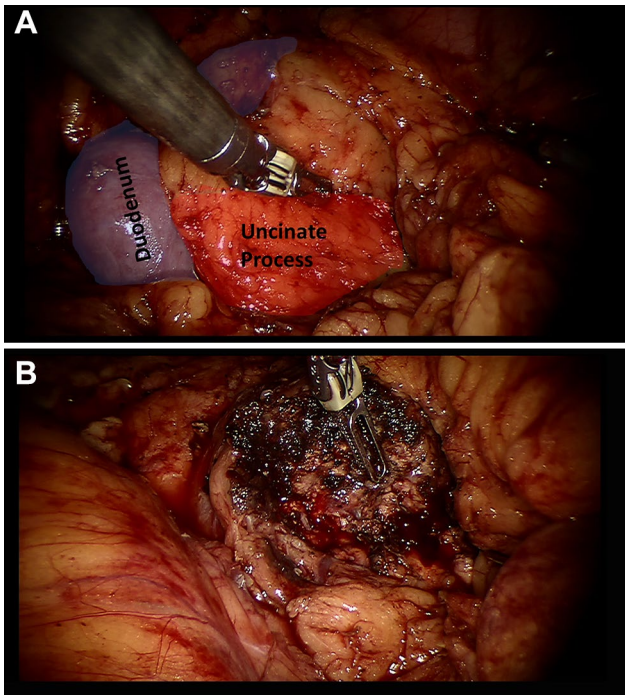

Fig. 4 Intraoperative view. **a** Limits of the uncinate process is determined. **b** View after resection of the uncinate process of the pancreas

Discussion

Pancreatoduodenectomy is the treatment of choice for tumors arising in the head of the pancreas and the periampullary area. However, some low-grade neoplasms might benefit from pancreatic-sparing techniques, such as enucleation and isolated resection of the uncinate process of the pancreas. Enucleation is often performed, but we believe that it is more suitable in the body and tail of the pancreas, where the organ is thinner. In the uncinate process, deep located lesions, such as the present case, might be better resected with isolated removal of this part of the pancreas.

Isolate resection of the uncinate process of the pancreas, although described in 1996, has been rarely performed and reported [3–6]. This is mainly because it is a complex operation that needs accurate knowledge of the pancreatic anatomy. The uncinate process of the pancreas is merged to the head, and its limits are not easy to identify, especially its upper margin, which maintains a close relationship with the main pancreatic duct that must be preserved. Moreover,

the uncinate process has the superior mesenteric vein on its left border, where venous branches can be found and can cause massive bleeding if the plane of dissection is not accurate. In the lower and right limits, there is an arterial arcade, formed by the IPA, which is responsible for the perfusion of the duodenum and must be preserved. This plane of dissection should preserve the IPA while controlling its arterial branches towards the uncinate process.

Minimally invasive resection of the uncinate process of the pancreas was reported in 2009 by our group, and since then, this technique has been successfully employed in several patients [4]. The present manuscript reports the first case performed totally by the robotic approach. Robotic surgery has well-described advantages over the laparoscopic approach, including three-dimensional high-definition vision, motion-scaling, tremor filtration, and seven degrees of freedom with internal articulated movements. These features might overcome some of the technical limitations of laparoscopy and extend the use of a minimally invasive approach to a great number of procedures.

One of the main difficulties when performing a resection of the uncinate process of the pancreas is to identify its upper limit and to preserve the main pancreatic duct. An unrecognized trauma to the main pancreatic duct can potentially lead to serious complications. Usually, during the open or laparoscopic approach, the use of intraoperative ultrasound can help with the identification of the main duct [7]. However, the main duct is frequently small and difficult to see. Therefore, intraoperative cholangiography is recommended in these situations, but the gallbladder is not always present, and this intraoperative imaging usually requires cholecystectomy. In the robotic approach, intraoperative cholangiogram can be performed with the use of indocyanine green enhanced fluorescence that facilitates the identification of the ampulla of Vater.

According to 2018 NCCN guidelines, pancreatic parenchymal-sparing surgery is indicated in selected patients with low-grade pancreatic neoplasms with a distance between tumor and main pancreatic duct ≥ 3 mm (no focal stricture or dilation) [8]. Robotic resection of the uncinate process combines the dual benefits of a minimally invasive technique and the pancreas-sparing approach.

Pancreatic fistula continues to be the main concern after resection of the uncinate process. There is no definitive study of its incidence after this complex operation due to the few publications on the subject. However, the previous experience from our team with this operation by either open or laparoscopic approach shows a lower incidence of clinically relevant pancreatic fistula (grades B and C), but a relatively high incidence of the biochemical leak (grade A pancreatic fistula definition in the previous classification). A simple and effective way to prevent a complicated postoperative course is to adequately drain the raw pancreatic area. In the present case, the patient experienced a biochemical leak with an uneventful outcome. Both endocrine and exocrine pancreatic functions were preserved.

In conclusion, robotic resection of the uncinate process of the pancreas is safe and feasible, providing parenchymal conservation in a minimally invasive setting. Robotic resection should be considered for patients suffering from low-grade pancreatic neoplasms located in this part of the pancreas.

Compliance with ethical standards

Conflict of interest Marcel Autran Machado, Rodrigo Surjan, Tiago Basseres, and Fabio Makdissi declare that they have no conflict of interest.

Ethical statement All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975. Informed consent was obtained from the patient for being included in the study.

Consent section Written informed consent was obtained from the patient for publication of this Case Report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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