Case Series

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Laparoscopic antegrade spleen-preserving distal pancreatectomy with conservation of the splenic vessels: a prospective multi-centre case series (with video)

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Introduction: Laparoscopic spleen-preserving distal pancreatectomy (LSPDP) with conservation of the splenic artery and vein (Kimura' technique) is considered a technically challenging procedure that requires a high level of expertise in laparoscopic and pancreatic surgery.

Methods: A prospective descriptive study on 18 patients with laparoscopic "antegrade" spleen-preserving distal pancreatectomy with Kimura' technique from 2018 to 2023. The perioperative indications, clinical data, intraoperative index, pathological postoperative specimens, postoperative complications, and follow-up results were retrospectively evaluated.

Results: The mean age was 39.4 ± 13.3. Only 2 male patients accounted for 11.1%. The average operating time is 171 ± 23 min. The average blood loss is 65.7 ± 43 ml. The average tumor size is 4.1 cm. The average hospitalization is 9.4 days. The rate of pancreatic fistula is 66.7%. There is no case of transferring open surgery or blood transfusion during surgery. The results of pathological after surgery there were eight cases of solid pseudopapillary tumors, four cases of mucinous cystadenoma, six cases of neuroendocrine tumors.

Conclusion: Kimura's technique for laparoscopic spleen-preserving distal pancreatectomy is safe and feasible, which can be applied to benign tumors in the body and tail of the pancreas. However, this is a difficult technique in laparoscopic surgery that requires surgeons to have a lot of experience and equipment need to be adequate.

Keywords: distal pancreatic tumor, Kimura' technique, laparoscopic antegrade spleen-preserving distal pancreatectomy

Introduction

The pancreas is a solid organ located behind the peritoneum. Tumors of the body and tail of the pancreas are relatively rare compared to tumors of the pancreatic head. Laparoscopic resection of the body and tail (distal) of the pancreas is increasingly widely applied for benign and low-grade malignant tumors in the distal pancreas[1]. Otherwise, there have been many studies demonstrating the role of the spleen in the body, especially immune function, so preserving the spleen in distal pancreatectomy is increasingly being focused on. Till now, there are two techniques for preserving the spleen during pancreatic tail or body resection: the Warshaw technique (1988) and the Kimura technique (1996)[2,3]. In Warshaw's approach, the splenic artery and vein are ligated at two locations—the pancreatic body and the splenic hilum. The remaining spleen parenchyma is supplied by short gastric branches. On the other hand, Kimura's technique preserves the entire splenic artery and vein, with only the branches along their path being ligated. This method avoids disrupting the overall blood supply to the spleen. Numerous studies, including recent systematic reviews, have demonstrated the benefits of preserving the splenic artery and vein, including a reduction in the rates of spleen infarction and post-surgery gastric varices[4,5]. This theoretically lowers the risk of complications such as splenic atrophy and splenic abscess, as well as gastrointestinal bleeding, when compared to the approach requiring the ligation of both the splenic artery and vein.

HIGHLIGHTS

- Tumors of the body and tail of the pancreas are relatively rare compared to tumors of the pancreatic head.
- Laparoscopic resection of the distal pancreas is increasingly widely applied for benign and low-grade malignant tumors in the distal pancreas.
- Laparoscopic spleen-preserving distal pancreatectomy with Kimura' technique is considered a technically challenging procedure.

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Laparoscopic "antegrade" spleen-preserving distal pancreatectomy (LSPDP) with conservation of the splenic artery and vein is a surgical procedure used to remove the distal portion of the pancreas while preserving the spleen and its blood supply. This technique is typically employed when there is a need to remove a part of the pancreas due to tumors or other diseases, but the preservation of the spleen is desirable to maintain immune function and avoid the risk of overwhelming post-splenectomy infection (OPSI). It offers the potential benefits of reduced postoperative pain, shorter hospitalization, and quicker recovery compared to traditional open surgery. However, the selection of patients for this procedure depends on various factors, including the size and location of the pancreatic lesion and the overall health of the patient, and moreover, LSPDP with conservation of the splenic vessels is considered a technically challenging procedure that requires a high level of expertise in laparoscopic and pancreatic surgery. So, our research analyzed the contributions of our technique in LSPDP with an antegrade approach and conservation of the splenic vessels with a multicenter experience of short-term outcomes.

Methods

Data collection

This case series has been reported in line with the PROCESS Guideline', Supplemental Digital Content 1, http://links.lww.com/MS9/A469 at the end of the methods section (and include the citation in the references section)[6] and was registered in accordance with the declaration of Helsinki. After an Institution Review Board approval, all patients with a histologically proven diagnosis of primary distal pancreatic benign neoplasms who underwent LSPDP with conservation of the splenic vessels at the Center of Gastrointestinal and Hepato-pancreato-biliary surgery, Bach Mai Hospital and the Department of Hepatobiliary-pancreatic Surgery, Hanoi Medical University Hospital for 5 years from 2018 to 2023 were enrolled. A multidisciplinary meeting was previously held in all cases including surgeons, radiologists, clinical pathologists, and oncologists for final strategy.

Patients' data were prospectively collected, including:

General and preoperative information: Demographic characteristics (sex, age, height, weight, BMI, medical history), tumor characteristics on the preoperative imaging workup [computed tomography (CT) and MRI], and patient's general physical status according to the American Society of Anesthesiologists (ASA) physical status classification system[7].

Intraoperative data and short-term outcomes: Blood loss, operative time, tumor dimension, pathological postoperative specimens, resected margins status, length of hospital stay, postoperative morbidity and 90-days mortality. The margin status was defined as follows: no cancer cells are identified microscopically at any of the resected margins (R0), microscopic tumor present (R1), and gross residual tumor as determined by the surgeon intraoperatively (R2). However, there hasn't been evidence base or consensus yet regarding the definition of R1 resection for liver cancer resections. Therefore, the distance between tumor cells and resection margin have been included in this study[8]. Postoperative complications were revised and classified based on Clavien-Dindo[9], and postoperative pancreatic fistula (POPF) according to the 2016 International Study Group (ISGPS) definition and grading updated version[10].

Surgical procedure

All cases have undergone preoperative multí-slice CT scan with angiography to determine the origin location as well as understand the anatomical changes of these vascular branches. All cases in the study were performed according to a unified surgical procedure with detailed step-by-step video, Supplemental Digital Content 2, http://links.lww.com/MS9/A470.

The patient is positioned supine with legs abducted, while the display screen is strategically situated above the patient's right shoulder. The instrument table is arranged at the patient's caudal end, hosting nursing equipment. The camera operator, positioned to the right of the patient, holds the camera, while the surgeon stands in the intercrural space. Simultaneously, the second assistant is stationed to the left of the patient. The position of five trocars as follows: The camera trocar is situated below the umbilicus, the 12-mm trocar is inserted along the left midclavicular line, crossing the umbilicus. The third trocar is placed beneath the ribs on the left anterior axillary line. The fourth trocar is positioned 2 cm above the umbilicus along the right anterior axillary line. Finally, the fifth trocar is inserted below the sternum.

Phase 1: Dissection procedures to expose the pancreas. Cut the pancreatic parenchyma

Gain access to the posterior omentum by traversing through the greater omentum, precisely at the location between the greater curvature and the colon. This maneuver facilitates the exposure of the complete body and tail of the pancreas. Proceed by releasing and mobilizing the pancreatic isthmus, situated just above the portal vein, spanning from the lower border to the upper border of the pancreas.

Divide the pancreatic parenchyma into two halves using a vascular stapler positioned at the isthmus of the pancreas. Control any bleeding at the pancreatectomy site by employing separate synthetic, monofilament non-absorbable sutures 4.0 and bipolar vessel-sealing.

Phase 2: Liberate the body and tail of the pancreas

Liberate antegrade the body and tail of the pancreas by dissecting from right to left and vice versa. Along the upper border of the pancreas, perform dissection along the splenic vascular bundle. Ligate the blood vessels that are separated from the splenic artery and vein. On the lower border, dissect the pancreas from the horizontal mesentery of the colon. Then, perform a resection of the entire body and tail of the pancreas, separating it from the splenic artery and vein.

After the resection, meticulously inspect for hemostasis to ensure the control of bleeding. Thoroughly clean the surgical site. Take appropriate specimens for further analysis as required. Additionally, place drains adjacent to the pancreatectomy site to facilitate postoperative drainage and monitoring.

Statistical analysis

Categorical variables were presented as a percentage of each value. Discrete variables were numeric variables that had a countable number of values between any two values. Continuous variables were expressed as mean (or median if without normal distribution) with range. Continuous variables were analyzed using the Wilcoxon rank sum test. Categorical variables were

analyzed using the χ^2 test or Fisher's exact test. Statistical analysis was performed using SPSS for Windows, version 22.0 (SPSS Inc.).

Results

Eighteen patients meeting the selection criteria were enrolled in the study. The subsequent findings are outlined below:

General and intraoperative data (Table 1)

The mean age of the participants was 39.4 ± 13.3 years. The study included only two male patients, constituting 11.1% of the total cohort. The average duration of the surgical procedures was 171 ± 23 min. The mean blood loss during surgery was 65.7 ± 43 ml. The average tumor size was 3.5 cm.

Short-term outcomes (Table 2)

The incidence of postoperative pancreatic fistula was 66.7% (12 patients), with level A pancreatic fistula representing 44.4% and level B pancreatic fistula accounting for 22.2%; there were no cases of level C pancreatic fistula. Among the total of 18 patients, none necessitated conversion to open surgery or blood transfusion during the initial surgery. Two cases required re-operation due to postoperative bleeding, with one instance undergoing laparoscopic surgery and another requiring open surgery due to hemorrhagic shock. The typical length of hospital stay was 9.4 days. There were no reported fatalities.

Histopathological data

Among the 18 cases, there were 8 instances of pseudopapillary solid tumors, 6 cases of neuroendocrine tumors, and 4 cases of mucinous cysts.

Discussion

In term of our technique, "Antegrade" signifies that the dissection proceeds in the natural or forward direction of the blood flow and anatomical orientation. In the case of spleen-preserving distal pancreatectomy, the term "antegrade" typically indicates that the surgeon is dissecting the pancreas from its proximal (or head) end towards its distal (or tail) end, following the direction of the pancreatic duct and blood vessels. This approach aims to preserve the blood supply and integrity of the spleen while removing the diseased portion of the pancreas. By dissecting in an "antegrade" fashion, surgeons can carefully identify and preserve the splenic vessels, which are crucial for maintaining blood flow to the spleen. The average age in our study was 35.4 ± 11.3, with the youngest patient being 11 years old (diagnosed with a pancreatic body pseudopapillary solid tumor) and the oldest patient being 61 years old (diagnosed with a pancreatic tail insulinoma). This variation in age distribution indicates that the disease can manifest across all age groups. Notably, the incidence of the disease is more prevalent in women, as evidenced by only one male patient, constituting 8.3% of the total cases. This finding aligns with the research of other authors[11,12].

There are scarce worldwide reports on laparoscopic splenectomy for pancreatic tail and body cases, and the existing studies involve a limited number of patients. Between 2000 and 2003, Han performed surgeries on five patients, revealing postoperative pathology with two cases of serous cysts, two cases of mucinous cysts, and one case of pseudopapillary solid tumor. The average operating time was 348 min, and the average hospital stay was 10.4 days[13]. In a series of cases presented by Akira Sasaki from 2003 to 2007, involving three patients, the average surgery time was 158.3 min, with minimal blood loss (average 14.7 ml). The average tumor size was 29.3 mm, and patients had an average hospital stay of 8.7 days[14]. Hiroo Uchida reported in 2010 on a 12-year-old case diagnosed with a solid pseudopapillary tumor of the pancreatic body. The patient underwent laparoscopic resection of the pancreatic body and tail, preserving the spleen using Kimura's technique[15]. In our study, which included 18 patients, the average surgery time was 182 ± 17 min, and the average intraoperative blood loss was 75.7 ± 50 ml. The average tumor size was 3.5 cm, and the average hospital stay was 9.4 days. Postoperative pathology confirmed that five cases were solid pseudopapillary tumors, four cases were neuroendocrine tumors, and three cases were mucinous cysts, all of which were benign. Comparisons between studies reveal significant variations in surgery time, hospital stay, tumor size, and postoperative pathology results. The diverse findings underscore the need for larger-scale studies to enable comprehensive comparisons and a better understanding of laparoscopic splenectomy outcomes in pancreatic surgeries.

Table 1

General and intraoperative data.

Characteristics	*N* = 18 (%)
Age (years), mean (range)	39.4 ± 13.3 (16–63)
Sex ratio (female: male)	16: 2
Operative time (median ± SD, min–max minutes)	171 ± 23 (128–210)
Estimated blood loss (median ± SD, min–max ml)	65.7 ± 43 (30–150)
Tumor diameter (cm), median (range)	3.5 (2.5–7)
Location of the tumor	
Body, *n*, (%)	10 (55.6)
Tail, *n*, (%)	8 (44.4)
Presence of compression of the splenic vein	
No, *n*, (%)	14 (77.8)
Yes, *n*, (%)	4 (22.2)

min, minimum; max, maximum.

Table 2

Short-term outcomes.

Index	*N* = 18
Type of postoperative complications, *n*, (%)	
Pancreatic fistula	12 (66.7)
Bleeding[a] (GI bleeding, peritoneal hemorrhage)	2 (11.1%)
Pancreatic fistula, *n*, (%)	
Grade A	8 (44.4)
Grade B	6 (22.2)
Grade C	0
Re-operations[a]	2 (11.1)
Length of hospital stay (mean ± SD, min–max days)	9.4 ± 1.3 (6–15)
In-hospital mortality, *n*, (%)	0

GI, gastrointestinal; min, minimum; max, maximum.

[a]Two cases required re-operation due to postoperative bleeding, with one instance undergoing laparoscopic surgery and another requiring open surgery due to hemorrhagic shock.

The English proverb "Pancreas is not your friend" implies that pancreatic surgery is associated with numerous potential complications. The most frequent complication following pancreatic tail body resection is pancreatic fistula. In the 2016 update of the International Pancreatic Fistula Study Group, the term "grade A pancreatic fistula" was renamed "biochemical fistula" to emphasize that it is not a true pancreatic fistula but rather an elevation in pancreatic fistula markers[10]. This is characterized by an amylase concentration in drainage fluid at least three times higher than the upper limit of serum amylase, without any clinical manifestations. In our series of 18 patients, 7 individuals (58.3%) experienced postoperative pancreatic fistula, primarily biochemical fistula (41.6%). Two cases were classified as grade B pancreatic fistula, and there were no instances of grade C pancreatic fistula. The detection of grade B pancreatic fistula involved postoperative abdominal drainage with milky white fluid and amylase testing in the fluid, which showed amylase levels many times higher than in the serum. Both cases were managed by retaining abdominal drainage for over 3 weeks. Upon reevaluation 3 weeks post-surgery, no additional fluid was observed in the abdominal drainage, and ultrasound scans revealed no localized fluid collection adjacent to the pancreatectomy site, prompting drain removal. Our observed rate of postoperative pancreatic fistula is notably higher than reported in the studies of Yong Fei Hua and colleagues (32.7%) and Jean-Philippe Adam and colleagues (16.3%)[11,12]. To mitigate the risk of pancreatic fistula after surgery, our surgical approach involves avoiding direct handling or pressure on the pancreatic parenchyma. Additionally, we administer octreotide early and regularly to all patients postoperatively. During the pancreatectomy procedure, pancreatic parenchyma is incised using a stapler with a 60mm vascular magazine. To minimize bleeding at the pancreatectomy site, careful compression of the pancreatic parenchyma is applied, holding the stapler in place for 2 min before cutting. In three cases, bleeding from the staple row necessitated stitching to reinforce the staple line using separate synthetic, monofilament non-absorbable sutures.

In all our patients, there were no instances requiring conversion to open surgery, and surgeries proceeded without complications or fatalities. However, two cases necessitated re-operation due to postoperative bleeding. In both instances, bleeding occurred on the second day after surgery, with one case successfully managed through endoscopic intervention to stop the bleeding, while the other required open surgery due to hemorrhagic shock. The intraoperative damage in both cases resulted from bleeding originating from a small branch along the path of the splenic artery. These cases highlighted the importance of a meticulous surgical approach when separating the pancreatic body parenchyma from the splenic artery and vein. It became evident that detecting and managing small side branches is crucial. These branches should be carefully identified and secured with clips or hemolocks during surgery. The use of an energy knife should be avoided due to the potential for corrosion by pancreatic juice after surgery, leading to secondary bleeding from these small branches. In some instances, bleeding may be temporarily stopped during surgery, masking the issue until postoperative bleeding occurs. The lessons learned from these cases emphasize the need for thorough attention to detail during the surgical process to prevent such complications.

LSPDP with conservation of the splenic artery and vein, following Kimura's technique, is recommended for cases involving benign or low-grade malignant tumors in these pancreatic regions. This approach is considered safe, feasible, and should be the primary choice. The key emphasis is on preserving the spleen parenchyma as it does not compromise the blood supply to the spleen. Preserving the splenic vascular bundle during laparoscopic surgery remains a complex and demanding aspect of pancreatic and splenic procedures, requiring careful planning, skilful execution, and adaptation to the individual patient's anatomy and pathology. Collaboration among multidisciplinary teams, including surgeons, radiologists, and anesthesiologists, is crucial to optimize outcomes and minimize complications. Kimura's technique is preferred due to its potential benefits. In instances where preservation of the splenic artery and vein is not feasible, Warshaw's technique involving the ligation of both the splenic artery and vein may be employed. However, it's essential to note that Warshaw's technique is challenging in the context of laparoscopic surgery. It requires a surgeon with a solid understanding of anatomy, extensive experience, and access to appropriate equipment for the procedure. The decision between Kimura's and Warshaw's techniques depends on factors such as the specific characteristics of the tumor, the patient's anatomy, and the surgeon's expertise. Kimura's technique is generally favored for its spleen-preserving benefits, but in certain situations where preservation is not possible, Warshaw's technique becomes a viable alternative. Regardless of the chosen technique, the success of the procedure is contingent upon the surgeon's skill, experience, and familiarity with the chosen approach.

Conclusion

Laparoscopic "antegrade" spleen-preserving distal pancreatectomy with conservation of the splenic artery and vein is considered safe, feasible, and should be the primary choice for cases involving benign or low-grade malignant tumors in these pancreatic regions. The decision between Kimura's and Warshaw's techniques depends on factors such as the specific characteristics of the tumor, the patient's anatomy, and the surgeon's expertise.

Ethical approval

Ethics approval of this study (No. 691-GCN-HĐĐĐNCYSH-ĐHYHN) was given by the Research Ethics Committees of Hanoi Medical University Hospital, Hanoi, Vietnam on 12 December 2018. Written informed consent for publication of their clinical details and clinical images was obtained from the patients' family.

Consent

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

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The authors declare no funding for this study.

Author contribution

H.N.: conceived, performed the operation, and wrote the manuscript. T.H.L.: performed the operation and wrote the

manuscript. T.K.N. and A.K.N.: performed the operation and edited the manuscript. All authors read and approved the final manuscript to submit.

Conflicts of interest disclosure

The authors declare no conflict of interest regarding the publication of this article.

Research registration unique identifying number (UIN)

This case series was registered in accordance with the declaration of Helsinki (ID: researchregistry9937, link: https://www.researchregistry.com/registernow#home/registrationdetails/65ab56b48d25fe0029ade724/).

Guarantor

Hoang Nguyen.

Data availability statement

All data generated or analyzed during this study are included in this published article.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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References

[1] Mehrabi A, Hafezi M, Arvin J, *et al*. A systematic review and meta-analysis of laparoscopic versus open distal pancreatectomy for benign and malignant lesions of the pancreas: it's time to randomize. Surgery 2015;157:45–55.
[2] Kimura W, Inoue T, Futakawa N, *et al*. Spleen-preserving distal pancreatectomy with conservation of the splenic artery and vein. Surgery 1996;120:885–90.
[3] Warshaw AL. Conservation of the spleen with distal pancreatectomy. Arch Surg 1988;123:550–3.
[4] Hang K, Zhou L, Liu H, *et al*. Splenic vessels preserving versus Warshaw technique in spleen preserving distal pancreatectomy: a systematic review and meta-analysis. Int J Surg 2022;103:106686.
[5] Granieri S, Bonomi A, Frassini S, *et al*. Kimura's vs Warshaw's technique for spleen preserving distal pancreatectomy: a systematic review and meta-analysis of high-quality studies. HPB (Oxford) 2023;25:614–24.
[6] Agha RA, Sohrabi C, Mathew G, *et al*. The PROCESS 2020 Guideline: Updating Consensus Preferred Reporting Of CasESeries in Surgery (PROCESS) Guidelines. Int J Surg 2020;84:231–5.
[7] Doyle DJ, Hendrix JM, Garmon EH, American Society of Anesthesiologists Classification. 2023 Aug 17. *In: StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; 2024:28722969.
[8] Wyatt J, Hübscher S, Goldin R, *et al*, Dataset for histopathological reporting of liver resection specimens (including gallbladder) and liver biopsies for primary and metastatic carcinoma [Internet]. 2022.
[9] Clavien PA, Barkun J, de Oliveira ML, *et al*. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 2009;250:187–96.
[10] Bassi C, Marchegiani G, Dervenis C, *et al*. The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 Years After. Surgery 2017;161:584–91.
[11] Hua YF, Yadav DK, Bai X, *et al*. Laparoscopic spleen-preserving distal pancreatectomy (LSPDP) with preservation of splenic vessels: an inferior-posterior approach. Gastroenterol Res Pract 2018;2018:1683719.
[12] Adam J-P, Jacquin A, Laurent C, *et al*. Laparoscopic spleen-preserving distal pancreatectomy: splenic vessel preservation compared with the warshaw technique. JAMA Surg 2013;148:246–52.
[13] Han HS, Min SK, Lee HK, *et al*. Laparoscopic distal pancreatectomy with preservation of the spleen and splenic vessels for benign pancreas neoplasm. Surg Endosc 2005;19:1367–9.
[14] Sasaki A, Nitta H, Nakajima J, *et al*. Laparoscopic spleen-preserving distal pancreatectomy with conservation of the splenic artery and vein: report of three cases. Surg Today 2008;38:955–8.
[15] Uchida H, Goto C, Kishimoto H, *et al*. Laparoscopic spleen-preserving distal pancreatectomy for solid pseudopapillary tumor with conservation of splenic vessels in a child. J Pediatr Surg 2010;45:1525–9.