Values of spleen-preserving distal pancreatectomy in well-differentiated non-functioning pancreatic neuroendocrine tumors: a comparative study

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Abstract

Background  The feasibility of spleen-preserving distal pancreatectomy (SPDP) to treat well-differentiated non-functioning pancreatic neuroendocrine tumors (NF-pNETs) located at the body and/or tail of the pancreas remains controversial. Distal pancreatectomy with splenectomy (DPS) has been widely applied in the treatment of NF-pNETs; however, it may increase the post-operative morbidities. This study aimed to evaluate whether SPDP is inferior to DPS in post-operative outcomes and survivals when being used to treat patients with NF-pNETs in our institute.

Methods  Clinicopathological features of patients with NF-pNETs who underwent curative SPDP or DPS at the First Affiliated Hospital of Sun Yat-sen University (Guangzhou, China) between January 2010 and January 2022 were collected. Short-term outcomes and 5-year survivals were compared between patients undergoing SPDP and those undergoing DPS.

Results  Sixty-three patients (SPDP, 27; DPS, 36) with well-differentiated NF-pNETs were enrolled. All patients had grade 1/2 tumors. After identifying patients with T1–T2 NF-pNETs (SPDP, 27; DPS, 15), there was no disparity between the SPDP and DPS groups except for tumor size (median, 1.4 vs 2.6 cm, \( P = 0.001 \)). There were no differences in operation time (median, 250 vs 295 min, \( P = 0.478 \)), intraoperative blood loss (median, 50 vs 100 mL, \( P = 0.145 \)), post-operative major complications (3.7% vs 13.3%, \( P = 0.287 \)), clinically relevant post-operative pancreatic fistula (22.2% vs 6.7%, \( P = 0.390 \)), or post-operative hospital stays (median, 9 vs 9 days, \( P = 0.750 \)) between the SPDP and DPS groups. Kaplan–Meier curve showed no significant differences in the 5-year overall survival rate (100% vs 100%, log-rank \( P > 0.999 \)) or recurrence-free survival (100% vs 100%, log-rank \( P > 0.999 \)) between patients with T1–T2 NF-pNETs undergoing SPDP and those undergoing DPS.

Conclusions  In patients with T1–T2 well-differentiated NF-pNETs, SPDP could achieve comparable post-operative outcomes and prognosis compared with DPS.

Key words: pancreatic neuroendocrine tumor; distal pancreatectomy; spleen preservation; prognosis
Introduction
Provided pancreatic neuroendocrine tumors (pNETs) are rare tumors arising from neuroendocrine cells and their prevalence has been steadily rising in recent years [1]. pNETs can be classified as functioning (F-pNETs) or non-functioning (NF-pNETs) pNETs based on their ability to secrete biologically active hormones and cause characteristic symptoms [2]. Most pNETs are NF-pNETs that are often accidentally discovered in patients [3]. Despite the improvement in systemic therapies, surgical resection remains the treatment of choice for patients with resectable pNETs [4]. For patients with pNETs located at the pancreatic body and/or tail, distal pancreatectomy with splenectomy (DPS) and lymphadenectomy is the recommended surgical modality. The advantages of simultaneous resection of spleen in distal pancreatectomy include facilitation of pancreatectomy and regional lymphadenectomy, hence it has been widely applied in the management of patients with pNETs at the pancreatic body and/or tail. Unfortunately, it may increase the post-operative morbidities, including thrombocytosis, elevation of thromboembolism risks, potential unfavorable immunological impacts, and elevation of post-operative pancreatic fistula (POPF) [5–7].

As the most common F-pNET, for insulinaoma located in the pancreatic body and/or tail, enucleation or spleen-preservation distal pancreatectomy (SPDP) is feasible given its good prognosis [8, 9]. However, the feasibility of SPDP for patients with NF-pNETs located at the pancreatic body and/or tail remains controversial, since it is technique-requiring due to the difficulties in dissecting the pancreatic body and tail from the splenic vessels and hilum, and there exists fear of inadequate oncological resection.

With the development of minimally invasive techniques, especially robotic-assisted approaches, its highly magnified 3D vision field and dexterous manipulation of instruments facilitate preservation of the spleen in distal pancreatectomy [10]. However, the 5-year survival of patients with NF-pNETs at the pancreatic body and/or tail who were treated with SPDP have not been well documented.

This study aimed to compare on the outcomes between patients with NF-pNETs undergoing SPDP and those undergoing DPS in our single institute.

Materials and methods
Patient selection
Patients with NF-pNETs who underwent SPDP or DPS between January 2010 and January 2022 were included in this study. The inclusion criteria were as follows: (i) preoperatively diagnosed as local pNET located at the pancreatic body and/or tail and pathologically confirmed as NF-pNET; and (ii) treated with curative distal pancreatectomy. The exclusion criteria included (i) coexistence of other malignancies; (ii) treated with palliative or debulking surgery; (iii) occurrence of synchronous liver metastasis or other distant metastasis; or (iv) pathologically confirmed as pancreatic neuroendocrine carcinoma. Finally, 63 patients with well-differentiated NF-pNETs were enrolled in this study (Figure 1). This study was approved by the Ethics Committee of the First Affiliated Hospital of Sun Yat-sen University, Guangzhou, China (Approval Number: [2022]008).

Data collection and perioperative management
Clinicopathological data were retrospectively collected, including preoperative laboratory and imaging details, operative findings, tumor characteristics, and post-operative course. Functional status was assessed according to the presence of a detectable elevated serum level of the relevant hormone associated with a clinical syndrome. All patients were evaluated preoperatively by at least two imaging tools, including computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography, or gallium 68 DOTANOC PET-CT scan.

The surgical plan was determined by a multidisciplinary team. Patients were treated with curative SPDP or DPS via open surgery or minimally invasive surgery, including laparoscopic surgery and robotic-assisted surgery. All patients were administered with prophylactic somatostatin or somatostatin analogue post-operatively. The level of drainage fluid amylase was tested on post-operative Days 1, 3, 5, and 7. Post-operative complication was evaluated according to the Clavien–Dindo classification [11]. Complications with severity of ≥grade III were defined as major complications. The definition of POPF was determined according to the 2016 International Study Group of pancreatic surgery (ISGPS) definition and the grading of post-operative pancreatic fistula [12]. Clinically relevant POPF (CR-POPF) includes grade B and grade C POPF.

All patients were followed up until death or censored at the cut-off date of May 2022. The outcomes measured were overall survival (OS) and recurrence-free survival (RFS). OS was defined as the interval between the date of surgery and the date of death or the last follow-up. Recurrence was defined as finding(s) of tumor recurrence on CT, MRI, ultrasound, or PET-CT scan.

Statistical analysis
All statistical analyses were performed using SPSS version 24.0 software (IBM, Inc., Armonk, NY, USA). The categorical variables are presented as frequencies with percentages, whereas the continuous variables are presented as medians with interquartile range (IQR). Differences between categorical variables were compared using the chi square test or Fisher’s exact test. Differences between continuous variables were compared using the Mann–Whitney U test. A Kaplan–Meier curve was used to calculate the OS and RFS. Two-tailed P < 0.05 was considered statistically significant.

Results
Comparison of clinicopathological features of patients with well-differentiated NF-pNETs undergoing SPDP and DPS
A total of 63 patients with well-differentiated NF-pNETs who underwent distal pancreatectomy were enrolled in this study, including 27 cases of SPDP and 36 cases of DPS. The clinicopathological features of patients were compared between the SPDP and DPS groups (Table 1). The SPDP group had smaller tumors than the DPS group (median of tumor size, 1.4 vs 4.4 cm, P < 0.001). All patients undergoing SPDP and DPS had G1/G2 tumors; there were no G3 tumors in either group. After identifying 42 patients with T1–T2 NF-pNETs, there was no disparity between the SPDP and DPS groups except for tumor size (median, 1.4 vs 2.6 cm, P = 0.001).

Comparison of short-term outcomes of patients with well-differentiated NF-pNETs undergoing SPDP and DPS
The operative details and short-term outcomes of patients with NF-pNETs were compared between the SPDP and DPS groups (Table 2). In patients with T1–T2 NF-pNETs, the minimally invasive rate was 100% in the SPDP group (laparoscopic surgery,
29.6%; robotic-assisted surgery, 70.4%) and 80.0% in the DPS group (laparoscopic surgery, 20.0%; robotic-assisted surgery, 60.0%), with a conversion rate of 3.7% (1/27) and 16.7% (2/12) in the SPDP and DPS groups, respectively. All the spleen-preserving procedures were performed via the Kimura technique. There were no differences in operation time (median, 250 vs 295 min, \( P = 0.478 \)), intraoperative blood loss (median, 50 vs 100 mL, \( P = 0.145 \)), blood transfusion (3.7% vs 6.7%, \( P = 1.000 \)), post-operative complications with severity of \( \geq \)Clavien-Dindo Grade III (3.7% vs 13.3%, \( P = 0.287 \)), CR-POPF (22.2% vs 6.7%, \( P = 0.390 \)), or post-operative hospital stays (median, 9 vs 9 days, \( P = 0.750 \)) between the SPDP and DPS groups. There was no mortality in either group. Fewer lymph nodes were obtained in the SPDP group than in the DPS group (median, 0 vs 2, \( P = 0.013 \)), but

Table 1. Comparison of clinicopathological characteristics of patients with well-differentiated non-functioning pNETs undergoing SPDP and DPS

| Feature                             | All patients | Patients with T1–T2 diseases |
|-------------------------------------|--------------|-------------------------------|
|                                     | SPDP (n = 27) | DPS (n = 36) | P-value*   | SPDP (n = 27) | DPS (n = 15) | P-value*   |
| Age (range), years                  | 48 (37–59)   | 51 (38–60) | 0.906c     | 48 (37–59)   | 48 (33–54) | 0.423c     |
| Sex, no. of males (%)               | 15 (55.6%)   | 19 (52.8%) | 0.827      | 15 (55.6%)   | 8 (53.3%)  | 0.890      |
| BMI (range), kg/m²                  | 23.1 (21.1–25.0) | 23.6 (20.8–26.1) | 0.662b     | 23.1 (21.1–25.0) | 23.7 (18.6–26.4) | 0.990b     |
| ASA classification, n (%)           | 25 (92.6%)   | 32 (88.9%) | 0.693b     | 25 (92.6%)   | 15 (100%)  | 0.530b     |
| I–II                                | 2 (7.4%)     | 4 (11.1%)  |            | 2 (7.4%)     | 0 (0%)      |            |
| III                                 | 3 (11.1%)    | 5 (13.9%)  | 1.000b     | 3 (11.1%)    | 2 (13.3%)  | 1.000b     |
| Diabetes, n (%)                     | 8 (29.6%)    | 6 (16.7%)  | 0.221      | 8 (29.6%)    | 3 (20.0%)  | 0.717b     |
| Hypertension, n (%)                 | 8 (29.6%)    | 16 (44.4%) | 0.231      | 8 (29.6%)    | 7 (46.7%)  | 0.270      |
| Symptom, n (%)                      |               |            |            |              |            |            |
| Median of tumor size (range), cm    | 1.4 (1.0–2.1) | 4.4 (2.7–6.0) | <0.001c    | 1.4 (1.0–2.1) | 2.6 (1.8–3.0) | 0.001c    |
| AJCC T stage, n (%)                 |               |            |            |              |            |            |
| T1–T2                               | 27 (100%)    | 15 (41.7%) | <0.001b    | 27 (100%)    | NA         | NA         |
| T3–T4                               | 0 (0%)       | 21 (58.3%) |            | 0 (0%)       | 0 (0%)     |            |
| WHO grade, G1/G2, n (%)             | 27 (100%)    | 36 (100%)  | NA         | 27 (100%)    | 15 (100%)  | NA         |
| LVI, n (%)                          | 3 (11.1%)    | 8 (22.2%)  | 0.326b     | 3 (11.1%)    | 2 (13.3%)  | 1.000b     |
| Neural invasion, n (%)              | 0 (0%)       | 3 (8.3%)   | 0.253b     | 0 (0%)       | 0 (0%)     | NA         |
| Vascular invasion, n (%)            | 0 (0%)       | 4 (11.1%)  | 0.128b     | 0 (0%)       | 0 (0%)     | NA         |

*Chi square test.  
*bFisher’s exact test.  
*cMann–Whitney U test.

pNET, pancreatic neuroendocrine tumor; SPDP, spleen-preserving distal pancreatectomy; DPS, distal pancreatectomy with splenectomy; BMI, body mass index; ASA, American Society of Anesthesiologists; AJCC, American Joint Committee on Cancer; WHO, World Health Organization; LVI, lymph-vascular invasion; NA, not available.
there was no significant difference in the rate of lymph-node metastasis (LNM) between the two groups (3.7% vs 6.7%, \( P = 1.000 \)).

**Comparison of survival of patients with well-differentiated pNETs undergoing SPDP and DPS**

The median follow-up time was 28.1 months. The median OS and RFS were not reached in either group. A Kaplan–Meier curve showed no significant differences in the 5-year OS (100% vs 100%, log-rank \( P > 0.999 \)) or 5-year RFS (100% vs 92.9%, log-rank \( P = 0.205 \)) between patients with NF-pNETs undergoing SPDP and those undergoing DPS (Figure 2). Subgroup analysis showed no significant difference in 5-year OS (100% vs 100%, log-rank \( P > 0.999 \)) or 5-year RFS (100% vs 100%, log-rank \( P > 0.999 \)) between patients with T1–T2 NF-pNETs undergoing SPDP and those undergoing DPS (Figure 2).

**Discussion**

Distal pancreatectomy can be performed combined with spleenectomy or spleen preservation. Several studies have shown the feasibility and potential benefits of preserving the spleen in distal pancreatectomy, including protecting the immune function and reducing the risk of overwhelming post-splenectomy infection, intraoperative blood loss, post-operative infections, and other complications due to splenectomy [13–15]. However, in order to avoid inadequate tumor resection, a spleen-preservation procedure was not applied in high-malignant lesions such as pancreatic adenocarcinoma [16]. In contrast, the use of SPDP for pre-cancerous or low-grade tumors such as pNETs remains controversial. A systemic review showed that 9%–16% of SPDPs were performed to treat patients with pNETs [17]. However, as the most common type of pNET, few studies focus on the value of SPDP in the long-term outcomes of NF-pNET patients such as OS and recurrence. Therefore, this study aimed at comparing the therapeutic value of SPDP with DPS in well-differentiated NF-pNETs in our single institute. After identifying patients with T1–T2 NF-pNETs, there was no disparity between the SPDP and DPS groups except for tumor size. There were no significant differences in the intraoperative or post-operative outcomes between the SPDP and DPS groups, which was comparable to the result of a previous report [18]. Survival analysis showed no significant differences in 5-year OS and RFS between patients with T1–T2 NF-pNETs undergoing SPDP and those undergoing DPS. Since the median tumor diameter differed by only 1.2 cm between the two groups, this study still demonstrated the safety and feasibility of SPDP in patients with T1–T2 NF-pNETs.

Regional lymphadenectomy is commonly recommended during resection of pNETs due to the potential risk of LNM. Although some studies demonstrated the prognostic value of the total number of lymph nodes examined (TNLE) and LNM in pNETs [19, 20], other research indicated that TNLE and LNM may have less important prognostic value in pNETs with some favorable characteristics (such as tumor <2 cm or Ki-67 index <3%) [21]. In this study, the median TNLE in patients undergoing SPDP was 0, which was significantly lower than in patients undergoing DPS in this study or those in previous studies [18]. Although achieving more lymph nodes can help with more accurate staging and avoid false-negative findings [22, 23], previous research proposed that the prevalence of LNM in pNETs is related to tumor size and tumor grade (Ki-67 index) [19, 24, 25], which indicated that LNM was unlikely to occur in patients with small G1 pNETs. In this study, since most of the patients treated with SPDP had G1 pNETs of <2 cm (19/27, 70.4%), the possibility of actual LNM might be low, which was also confirmed by the fact that only one patient had LNM. It suggested that SPDP may reduce the TNLE in patients with pNETs, resulting in insufficient accuracy of nodal staging. Nevertheless, no recurrence or tumor-related death occurred in all patients with T1–T2 NF-pNETs in this study. The significance of lymphadenectomy and TNLE in early-stage NF-pNETs needs to be further investigated.

| Feature | All patients | Patients with T1–T2 disease |
|---------|--------------|-----------------------------|
|         | SPDP (n = 27) | DPS (n = 36) | P-value* | SPDP (n = 27) | DPS (n = 15) | P-value* |
| Surgery approach, n (%) | | | 0.002b | | 0.076b |
| Open surgery | 0 (0%) | 12 (33.3%) | 0 (0%) | 3 (20.0%) | | |
| Laparoscopic surgery | 8 (28.6%) | 6 (16.7%) | 8 (29.6%) | 3 (20.0%) | | |
| Robotic-assisted surgery | 19 (70.4%) | 18 (50.0%) | 19 (70.4%) | 9 (60.0%) | | |
| Operation time, min | 250 (195–340) | 290 (206–356) | 0.266c | 250 (195–340) | 295 (205–375) | 0.478c |
| Intraoperative blood loss (range), mL | 50 (50–100) | 125 (50–200) | 0.015c | 50 (50–100) | 100 (50–200) | 0.145c |
| Blood transfusion, n (%) | 1 (3.7%) | 3 (8.3%) | 0.629b | 1 (3.7%) | 1 (6.7%) | 1.000b |
| Major complicationsd, n (%) | 1 (3.7%) | 5 (13.9%) | 0.226b | 1 (3.7%) | 2 (13.3%) | 0.287b |
| CR-POPF, n (%) | 6 (22.2%) | 4 (11.1%) | 0.303b | 6 (22.2%) | 1 (6.7%) | 0.390b |
| Mortality, n (%) | 0 (0%) | 0 (0%) | NA | 0 (0%) | 0 (0%) | NA |
| Post-operative stay (range), days | 9 (8–11) | 10 (9–12) | 0.416c | 9 (8–11) | 9 (8–11) | 0.750c |
| Number of lymph nodes examined (range) | 0 (0–1) | 2 (0–7) | 0.009c | 0 (0–1) | 2 (1–7) | 0.013c |
| Lymph-node metastasis, n (%) | 1 (3.7%) | 2 (5.6%) | 1.000b | 1 (3.7%) | 1 (6.7%) | 1.000b |

*aChi square test.  
*bFisher’s exact test.  
*cMann–Whitney U test.  
*dPost-operative complications with severity of ≥Clavien-Dindo grade III.
In this study, the 5-year OS and 5-year RFS of patients with T1–T2 NF-pNETs undergoing SPDP and DPS were 100%, which suggested that SPDP can achieve an ideal oncologic prognosis in patients with early-stage NF-pNETs when compared with the results of previous literature [18]. No recurrence or metastasis was observed in patients with T1–T2 NF-pNETs in this study. It is reasonable that recurrence may occur in patients with higher Ki-67 or larger tumors; therefore, higher Ki-67 or larger tumors were also considered poor prognostic factors in the recurrence and metastasis of pNETs after surgery. However, in the current study, even in some patients with a tumor size of ≥2 cm (7/27, 25.9%), a good prognosis can still be obtained after spleen preservation. Therefore, SPDP can achieve a comparable RFS and OS to DPS for NF-pNET patients if technically feasible.

This study revealed that SPDP can ensure radical resection of the tumor while preserving the spleen function in patients with T1–T2 NF-pNETs undergoing SPDP and DPS were 100%, which suggested that SPDP can achieve an ideal oncologic prognosis in patients with early-stage NF-pNETs when compared with the results of previous literature [18]. No recurrence or metastasis was observed in patients with T1–T2 NF-pNETs in this study. It is reasonable that recurrence may occur in patients with higher Ki-67 or larger tumors; therefore, higher Ki-67 or larger tumors were also considered poor prognostic factors in the recurrence and metastasis of pNETs after surgery. However, in the current study, even in some patients with a tumor size of ≥2 cm (7/27, 25.9%), a good prognosis can still be obtained after spleen preservation. Therefore, SPDP can achieve a comparable RFS and OS to DPS for NF-pNET patients if technically feasible.

In conclusion, this study revealed that although the number of examined lymph nodes may be lower in patients receiving SPDP than in those receiving DPS, the short-term outcomes and 5-year survival of patients with well-differentiated non-functioning pNETs who underwent SPDP was acceptable, especially in those with T1–T2 diseases. In addition, SPDP could preserve the function of the spleen and might improve the patients'
quality of life post-operatively. For small NF-pNETs with low risk of LNM, SPDP could be considered.

Authors’ Contributions
Conception and design: X.Y.Y. Collection and assembly of data: X.T.H., J.Z.X., J.P.C., P.F., C.S.H., W.C., L.J.L. Data analysis and interpretation: X.T.H., J.Z.X., X.Y.Y. Manuscript writing and revision: X.T.H., J.Z.X., Y.Y. All authors read and approved the final manuscript.

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Conflict of Interest
None declared.

References
1. Dasari A, Shen C, Halperin D et al. Trends in the incidence, prevalence, and survival outcomes in patients with neuroendocrine tumors in the United States. JAMA Oncol 2017;3:1335–42.
2. Wu J, Sun C, Li E et al. Non-functional pancreatic neuroendocrine tumours: emerging trends in incidence and mortality. BMC Cancer 2019;19:334.
3. Yao JC, Hassan M, Phan A et al. Trends in the incidence, prevalence, and survival outcomes in patients with neuroendocrine tumors in the United States. JCO 2008;26:3063–72.
4. Falconi M, Eriksson B, Kaltsas G et al.; Vienna Consensus Conference participants. ENETS consensus guidelines update for the management of patients with functional pancreatic neuroendocrine tumors and non-functional pancreatic neuroendocrine tumors. Neuroendocrinology 2016;103:153–71.
5. Kimura W, Yano M, Sugawara S et al. Spleen-preserving distal pancreatectomy with conservation of the splenic artery and vein: techniques and its significance. J Hepatobiliary Pancreat Sci 2010;17:813–23.
6. Jilesen AF, van Eijck CH, in’t Hof KH et al. Postoperative complications, in-hospital mortality and 5-year survival after surgical resection for patients with a pancreatic neuroendocrine tumor: a systematic review. World J Surg 2016;40:729–48.
7. Shi N, Liu SL, Li YT et al. Spleenic preservation versus splenectomy during distal pancreatectomy: a systematic review and meta-analysis. Ann Surg Oncol 2016;23:635–4.
8. Tsukahara T, Tanaka K, Nakanishi Y et al. Clinical impact of organ-preserving surgery for pancreatic neuroendocrine neoplasms: a single-center experience. Pancreas 2021;50:196–200.
9. Xu Q, Xie Q, Ge C et al. Risk factors and prevention of postoperative pancreatic fistula after insulinoma enucleation: a retrospective study from a high-volume center. Pancreatology 2021;21:1208–15.
10. Korrel M, LoF S, Sarireh BA et al. Short-term outcomes after spleen-preserving minimally invasive distal pancreatectomy with or without preservation of splenic vessels: a pan-European retrospective study in high-volume centers. Ann Surg 2021 Jun 2.
11. 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.
12. Bassi C, Marchegiani G, Dervenis C et al.; International Study Group on Pancreatic Surgery (ISGPS). The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 years after. Surgery 2017;161:584–91.
13. Di Sabatino A, Carsetti R, Corazza GR. Post-splenectomy and hyposplenic states. Lancet 2011;378:86–97.
14. Tsouris A, Cogan CM, Velanovich V. Distal pancreatectomy with or without splenectomy: comparison of postoperative outcomes and surrogates of splenic function. HPB (Oxford) 2011;13:738–44.
15. Pendola F, Gadde R, Ripat C et al. Distal pancreatectomy for benign and low grade malignant tumors: short-term postoperative outcomes of spleen preservation—a systematic review and update meta-analysis. J Surg Oncol 2017;115:137–43.
16. Abe T, Ohuchida K, Miyasaka Y et al. Comparison of surgical outcomes between Radical Antegrade Modular Pancreateosplenectomy (RAMPS) and Standard Retrograde Pancreateosplenectomy (SPRS) for left-sided pancreatic cancer. World J Surg 2016;40:2267–75.
17. Jain G, Chakravartty S, Patel AG. Spleen-preserving distal pancreatectomy with and without splenic vessel ligation: a systematic review. HPB (Oxford) 2013;15:403–10.
18. Sahara K, Tsilimigras DI, Moro A et al. Long-term outcomes after spleen-preserving distal pancreatectomy for pancreatic neuroendocrine tumors: results from the US Neuroendocrine Study Group. Neuroendocrinology 2021;111:129–38.
19. Hashim YM, Trinkaus KM, Linehan DC et al. Regional lymphadenectomy is indicated in the surgical treatment of pancreatic neuroendocrine tumors (PNETs). Ann Surg 2014;259:197–203.
20. Zhang XF, Xue F, Dong DH et al. New nodal staging for primary pancreatic neuroendocrine tumors: a multi-institutional and national data analysis. Ann Surg 2021;274:e28–35.
21. Wu L, Sahara K, Tsilimigras DI et al.; and other members of the US Neuroendocrine Tumor Study Group. Therapeutic index of lymphadenectomy among patients with pancreatic neuroendocrine tumors: a multi-institutional analysis. J Surg Oncal 2019;120:1080–6.
22. Huang XT, Huang CS, Li JH et al. Evaluating the adequacy of nodal status in node-negative gallbladder cancer with T1b–T2 stages: use of nodal staging score. HPB (Oxford) 2021;23:795–801.
23. Huang XT, Huang CS, Li JH et al. Use of nodal staging score in evaluating the accuracy of pathologic nodal status in node-negative ampullary carcinoma. J Gastrointest Surg 2021;25:1001–9.
24. Partelli S, Gaujoux S, Boninsegna L et al. Pattern and clinical predictors of lymph node involvement in functioning pancreatic neuroendocrine tumors (NF-PanNETs). JAMA Surg 2013;148:392–9.
25. Lopez-Aguilar AG, Ethun CG, Zaidi MY et al. The conundrum of ≤2-cm pancreatic neuroendocrine tumors: a preoperative risk score to predict lymph node metastases and guide surgical management. Surgery 2019;166:15–21.