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Solid pseudopapillary neoplasms of the pancreas

Is there a factor determining the prognosis? Experience of a single institution

Pinar Tasar, MD[a], Sadik Ayhan Kilicturgay, MD[a,*]

Abstract

Solid pseudopapillary neoplasms (SPNs) are frequently seen in young women. Although the behavior pattern varies, these rare lesions generally have a low malignant potential. In this study, the aim was to investigate the effect of clinicopathological features of lesions on the recurrence in and survival of patients. In this study, patients of our clinic who were pathologically diagnosed with SPN after pancreatic surgery between July 2008 and December 2020 were evaluated retrospectively. Patients' age, gender, comorbidities, symptoms at the time of application, preoperative CA 19-9, CEA value, preoperative cross-sectional diagnostic imaging method and lesion characteristics, surgery, postoperative complications, length of hospital stay, and histopathological features were evaluated. Early and late mortality, overall survival, disease-free survival, and recurrence rate were determined. Four of the 23 patients diagnosed with SPN were male and the median age was 29 (23–47) years. Of the study patients, 69.56% experienced pain symptoms and 30.43% were asymptomatic. The median tumor size was 4 cm (1.5–15). The most common surgical procedure was distal pancreatectomy (56.5%). The median length of hospital stays was 5 (3–120) days and morbidity was observed in 9 cases (39.13%). The mortality rate was 4.35%. The mean follow-up period in the series was 53 (8–132) months and none of the patients developed recurrence. In this study, no significant difference was found regarding recurrence in patients with SPN with histopathologically aggressive biological behavior. The overall survival rate was 95.7%. SPNs are rare lesions with low malignant potential. SPNs are associated with longer-term survival after surgical resection.

Abbreviations: BMI = Body mass index, CT = computarized tomography, DGE = delayed gastric emptying, EUS = endoscopic ultrasound, LHS = length of hospital stay, MR = magnetic resonance radiography, NETs = neuroendocrine tumors, POPF = pancreatic fistula, ROC = receiver operating characteristic, SPN = solid pseudopapillary neoplasm, SPNs = solid pseudopapillary neoplasms, US = ultrasonography

Keywords: mortality, prognosis, recurrence, solid pseudopapillary neoplasia, surgery

1. Introduction

Pancreatic solid pseudopapillary neoplasm (SPN) was first described by Frantz in 1959 and different terminologies have been used until now. It was finally classified as SPN by the WHO in 2010.[1,2] Today, its incidence is increasing due to the widespread use of imaging techniques. It constitutes 10–15% of all pancreatic cystic neoplasms and <2% of exocrine pancreatic neoplasms.[3,4] SPNs are frequently seen in young women under 40 years of age and are rare lesions with low malignant potential, although the behavior pattern varies.[5–7] They usually grow slowly and can reach large sizes without causing symptoms. Although patients are often asymptomatic, they may have nonspecific symptoms such as weight loss, dyspepsia, and pain. Although rare, palpable masses can be detected. SPNs are usually detected incidentally by abdominal ultrasonography (US) and/or abdominopelvic computarized tomography (CT), and magnetic resonance radiography (MR). They are cystic-solid lesions with a well-defined capsule, and a solid structure or a solid component in the peripheral section.

Problems experienced in the diagnosis of these borderline tumors and the uncertainty of which factors affect recurrence and survival after surgery remain. Although the diagnosis can be made easily by a characteristic radiological appearance such as an encapsulated mass, hemorrhage or cystic degeneration, and peculiar epidemiology, it should be distinguished from a neuroendocrine tumor or mucinous cystic neoplasia when detected incidentally.[8] Since SPNs are typically clearly distinguished from adjacent nonneoplastic pancreatic tissue, they can be curatively treated (5-year survival rate of 95–98%) with various surgical methods, such as distal pancreatectomy and pancreaticoduodenectomy, including enucleation, depending on localization and size.[4,5,9,10] It was suggested that possible indicators of the malignant behavior of SPN are an infiltrative growth pattern, capsule or pancreatic parenchymal invasion, lymph node metastasis, and vascular involvement, which were suggested

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

[a] *Department of General Surgery, School of Medicine, Uludag University, Gorukle, Bursa, Turkey.*

**Correspondence: Sadik Ayhan Kilicturgay, Department of General Surgery, Uludag University, Gorukle, Bursa/Turkey (e-mail: sturgay@uludag.edu.tr).*

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to be significant for recurrence, together with various histopathological features such as nuclear pleomorphism, apparent necrosis, and an increased mitotic rate. However, pathological criteria could not be clearly defined due to the small number of cases.[7,11,12] Organ invasion from infiltrative spread and metastatic lesions are encountered in 10–15% of cases and wide resections with negative margins were shown to influence survival.[7,13] Therefore, it is important to rapidly implement the appropriate surgical approach for the treatment of these lesions, specifically by distinguishing them from other cystic neoplasms. On the other hand, some studies reported good results regarding chemoradiotherapy in unresectable patients[5,11]

The primary endpoint of this study was to evaluate the effects of clinical-pathological features of SPN on recurrence in and survival of patients after surgical resection. The secondary endpoint was to assess the effectiveness of the methods applied in the diagnosis and treatment.

2. Materials and Methods

In this study, patients who were pathologically diagnosed with SPN after pancreatic surgery at the General Surgery Department of Bursa Uludag University between January 2008 and December 2020 were retrospectively screened. The study was approved by the ethics committee of our university (approval number: 2021-6/59). Patients' demographic characteristics, comorbidities such as diabetes-hypertension, symptoms related to the disease at the admission, preoperative CA 19-9 and CEA values, preoperative cross-sectional diagnostic imaging methods and lesion characteristics, surgery, surgical morbidity (bleeding, pancreatic fistula (POPF), lymphatic fistula, delayed gastric emptying (DGE), reoperation), 30-day mortality, and length of hospital stay (LHS) were examined. The criteria of the "International Study Group of Pancreatic Surgery" were used for POPF.[14]

To evaluate long-term outcomes (local recurrence, distant metastasis, and late disease-related mortality), the final condition of all patients was evaluated via file notes and phone calls, and necessary examinations were made.

The diagnosis of SPT was confirmed by 2 experienced pathologists. Tumor localization, tumor size, tumor pattern (solid, cystic), necrosis, mitotic activity, presence of calcification, and surgical margin were evaluated pathologically. Moreover, histopathological features of aggressive biological behavior such as nuclear atypia, lymph node involvement, pancreatic parenchymal invasion, peripancreatic adipose tissue invasion, lymphovascular and perineural invasion were examined. Immunohistochemical findings including CD10, progesterone, Ki67 proliferation index, synaptophysin, chromogranin A, and Beta-catenin were also examined.

2.1. Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics v.23. Normality of the continuous variables was tested using the Shapiro–Wilk test. Mean ± standard devition or median (minimum-maximum) values were given for normal and nonnormal data, respectively. Mann–Whitney U test was used to compare numerical variables between 2 independent groups. Categorical variables were presented with frequencies and percentages. Categorical variables were compared between the groups using Fisher exact chi-square test. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the performance of tumor size in distinguishing between those with and without a Cystic component. $P < .05$ was accepted as statistically significant.

3. Results

Of the 670 patients who were operated on for pancreatic neoplasia between January 2008 and December 2020, 89 were operated on with a prediagnosis of cystic neoplasia. Twenty-three of these patients were histopathologically diagnosed with SPN. Of the patients, 19 (82.6%) were female and 4 (17.4%) were male (Table 1). The median age of the patients was 29 (23–47) years, and the mean body mass index(BMI) was 29 ± 1.75. The most common symptom was abdominal pain (69.56%). One patient (4.3%) had a palpable mass. 30.43% of the patients were asymptomatic and SPN was detected incidentally during examinations performed for other reasons. 56.53% of the patients had no comorbidity. In the preoperative evaluation, CA 19-9 increase (73 U/ml) was detected in only 1 patient (normal CEA value), and the CEA and CA 19-9 values were normal in the remaining 22 patients.

In all cases, CT or MR examinations were performed together with US. Both examinations (CT-MR) were performed on

Table 1

Characteristics of patients treated for solid pseudopapillary neoplasm (n = 23)

Clinical and surgical characteristics	n:23
Age (yr)*	29 (23–47)
Gender (female/male)	19/ 4
BMI (kg/m^2)†	29 ± 1,75
Smokers	3
Alcohol abuse	0
Asymptomatic	7
Symptoms	
Abdominal pain	16
Vomiting	3
Palpable mass	1
Comorbidities	10
Diabetes	2
Hypertension	4
Coronary artery disease	2
Arrhythmia	1
Chronic obstructive pulmonary disease	3
Other	3
Location	
Head	9
Body	6
Tail	8
Radiologic characteristics	
Solid	10
Cystic	4
Mixed	9
Main pancreatic duct dilatation (>4 mm)	2
Ca 19.9 > 37 U/ml	1
Type of surgery	
Enucleations	4
Whipple	5
Distal pancreatectomy, with splenectomy	10
Distal pancreatectomy, spleen preserving	3
Central pancreatectomy	1
Morbidity	9
Grade B POPF	1
Grade B POPF + intraabdominal abscess	3
Grade B POPF + intraabdominal hemorrhage	1
Grade C POPF + intraabdominal abscess	1
Intraabdominal hemorrhage	1
Superficial surgical site infection	1
Pulmonary complication	1
Lymphatic fistula	0
Delayed gastric emptying	0
Mortality	1
Length of hospital stay (d)*	5 (3–120)
Readmission	2 (8,7)
Follow-up period (mo)*	53 (8–132)
Recurrence	0

*Mean ± SD.

†Median (min–max).

7 patients, only CT was performed on 11 patients and only MR was performed on 4 patients. In 1 case, a lesion was detected in the preoperative USA. The number of pure cystic lesions that appeared radiologically was 4 (17.4%). A heterogeneous structure was detected in 9 cases and a solid structure was detected in the remaining 10 cases.

The lesions were localized in the head of the pancreas in 9 patients, in the body in 6 patients, and in the tail in 8 patients. Pancreatic duct dilatation was seen in only 2 patients. The lesions of these 2 patients were in the head of the pancreas. In all other patients, the diameter of the pancreatic duct was <4 mm. The general median tumor size was 4 (1.5–15) cm. The median tumor size was 5 (1.5–15) cm in women and 2.25 (1.9–4.8) cm in men. Although this difference was statistically insignificant (P = .06), the diameter of the lesions encountered in women was larger compared to men. The most common surgical procedure was distal pancreatectomy (56.5%). Splenectomy was also performed on 10 of the 13 patients who underwent distal pancreatectomy. Lesions in all of the 4 patients (17.4%) who underwent enucleation were localized in the head of the pancreas. The Whipple procedure was performed in the other 5 cases with pancreatic head localization. Central pancreatectomy was also performed on a patient with a diameter of 1.5 cm localized in the neck of pancreas.

Surgical morbidity was 39.13% (n: 9 cases). Medical treatment was administered to a patient who developed hemorrhage in the early postoperative period and underwent distal pancreatectomy and splenectomy. Due to the development of intraabdominal hemorrhage, surgical hemostasis was performed on a patient who underwent distal pancreatectomy and developed grade B pancreatic fistula. Due to the development of grade B pancreatic fistula, percutaneous drainage was performed on 4 patients in total: 2 patients who underwent distal pancreatectomy and splenectomy, 1 patient who only underwent distal pancreatectomy, and 1 patient who underwent central pancreatectomy. Three of these patients also had an intraabdominal abscess. One patient developed a superficial surgical site infection and 1 developed atelectasis. One enucleated patient died on the 39th postoperative day after repeated operations due to grade C pancreatic fistula and an intraabdominal abscess. Mortality was 4.35%. The length of hospital stays were 5 (3–120) days. The rate of readmission in the first 30 days was 8.7% with 2 cases. Bleeding was brought under control by surgical intervention in one of these cases and the abscess was drained in the other patient using radiological intervention.

The median follow-up period was 53 months (8–132). No patients had evidence of postoperative recurrence of SPN. The survival rate was 95.7% (Table 1).

Lymph node metastasis was not detected in any of the patients in the histopathological evaluation (Table 2). Necrosis and mitosis were not detected in any of the patients whereas 4 patients had perineural invasion and 5 patients had mild cellular atypia. CD10 positivity was detected in all but one of the patients and progesterone receptor positivity was detected in 20 patients. Four patients had chromogranin A positivity and 7 had synaptophysin positivity. All patients were β-catenin positive. In the study, it was found that there was no statistically significant effect of gender and tumor diameter (<5 cm and others) on histopathological data (Ki67 proliferation index, nuclear atypia, perineural invasion) (p = NS). The median tumor size was 3 (1.5–13) cm in tumors without a pathologically cystic component whereas the median tumor size was 5.1 (3–15) cm in tumors with a cystic component. This difference was statistically significant (P = .04). ROC analysis was conducted to evaluate the performance of tumor diameter in distinguishing between those with and without a cystic component (AUC = 0.756, P = .01). According to the Youden-J index, the cut-off value for tumor size was >3 cm in distinguishing between those with and without a cystic component.

The Ki-67 proliferation index was 10% in only one of 4 patients with a Ki-67 proliferation index of ≥ 5%. Mild cellular atypia was detected in 2 of the 4 patients with a Ki-67 proliferation index of ≥ 5% and it was detected in 15.79% (3 cases) of the remaining 19 cases with a low Ki-67 proliferation index (P = .28).

4. Discussion

Although studies on SPNs appear as case reports and case series in the literature, the frequency of SPNs is increasing, especially with the screening and immunohistochemical evaluation methods that have been widely used for identification. Law et al reported that 87.3% of 2744 cases included in the studies published between 1960 and 2012 arose after 2000.[15] According to the literature, the mean age at diagnosis is 23–35 years and SPNs are more common in young women.[4,16] In general, the male to female ratio is 1:10; however, this ratio reaches 30% in some studies.[10,17] It was reported that SPN seen in men occurs especially in advanced age (5th decade), with larger sizes, more asymptomatically, and more aggressively.[10,17–19] In this study, males constituted 17.4% of the cases and were in the older age group (male median age: 53.5 (41–63) years, female median age: 25 (16–67) years) (P = .02). Although it was not statistically significant (P = .60), 50% of the male patients were asymptomatic whereas 26.3% of the female patients were asymptomatic.

Although the symptoms in patients are usually nonspecific, the most common symptom is pain. In this study, abdominal pain was the major complaint in all 16 symptomatic patients. The remaining 7 cases were diagnosed incidentally (30.43% of the cases were asymptomatic). The asymptomatic incidence rate is reported to be around 30% in the literature.[5,6] Law et al reported this rate as 38.1% in 2744 patients.[15] In this study, 4 cases detected incidentally had tumoral masses localized in the tail and 2 cases were head-localized, and 4 of these masses reached large sizes (>5 cm) before they became symptomatic. Fifty percent of tail lesions were detected incidentally whereas the rate for lesions in head localizations was 22%. In 10 cases with a total lesion size of ≥5 cm in the study, the median lesion diameter was 8.56 cm (min-max: 5–15 cm). Tumor diameter was

Table 2

Pathological characteristics of patients treated for solid pseudopapillary neoplasms (n = 23).

Pathological features	n:23
Size of lesion (cm)*	4 (1,5–15)
<5 cm (n = 13)	2,82 (1,5–4,8)
≥5 cm (n = 10)	8,56 (5–15)
Margin status (R0)	23
Calcifications	3
Pancreatic parenchyma invasion	8
Liver metastasis	0
Nodal metastasis	0
Harvested lymph nodes*	6 (0–15)
Presence of cystic component inconsistent with radiology	7
Necrosis and mitosis	0
Angiovascular invasion	0
Perineural invasion	4
Nucleer atypia	5
Chromogranin A positivity	4
Synaptophysin positivity	7
Progesterone receptor positivity	20
CD10 positivity	22
Ki67 proliferation index	
≥%5 positive	4
<%5 positive	19

*Median (min-max).

< 5 cm and the median lesion diameter was 2.82 cm (1.5–4.8 cm) in 13 cases. In this study, there was no correlation between symptoms and tumor size ($P = .11$). Similarly, Song et al did not find a correlation between size and symptoms,[20] whereas Hu et al reported that abdominal pain symptoms increased in large tumors.[21]

SPNs with a typical appearance of a well-defined and heterogeneous internal structure can be widely diagnosed with CT, MR, and endoscopic ultrasound (EUS). MR and EUS may provide more detailed information about tissue characteristics such as hemorrhage, cystic degeneration, and necrosis. Small lesions appear as homogeneous content in CT and large lesions appear as heterogeneous contrast enhancement. On the other hand, low-intensity lesions are seen on T1 images in MR and high-intensity lesions are seen on T2 and diffusion-weighted images.[10] The incidence of cystic components decreases due to bleeding into the tumor, especially in lesions larger than 5 cm.[22] The detection rate of SPNs with isolated diagnostic imaging is 50–70% and the use of multiple diagnostic imaging methods is recommended for an accurate preoperative diagnosis.[10] In this study, the lesion size was ≥ 5 cm in all 7 patients who did not have a cystic component on CT or MR but had a pathologically cystic component.

Although SPN can be seen in all parts of the pancreas, body and tail localizations are more common.[8,12,13,23] In this study, there was a similar distribution in all parts of the pancreas, whereas 60.9% were body and tail localizations, which form the distal part. In contrast, 63.6% of the lesions reaching large dimensions were localized in the body-tail.

SPNs are lesions with low malignant potential and an excellent prognosis with a 5-year survival rate of 95–98% after curative surgery. The recurrence rate in the literature ranges between 3 and 9%.[4,5,8,9,16] RO resection in SPN is the most critical point that determines the prognosis. Even vascular resections, which are simultaneous resections in patients with resectable metastatic liver lesions, and large resections with negative margins due to adjacent organ invasion, are appropriate treatment approaches for these lesions with slow growth patterns.[4,24] Lymph node metastasis is scarce in noninvasive SPNs (0–2%); therefore, adding the excision of suspected large lymph nodes to the surgical procedure instead of extended lymph node dissections is sufficient for curative surgery.[4,10,13,25,26] In this study, the median number of lymph nodes was found to be 7 (2–15) in the 16 cases with lymph nodes in the pathological evaluation of the resection material and no lymph node metastasis was detected in any of the patients. Since most SPNs are located in the tail and/or body of the pancreas, distal pancreatectomy is the most commonly applied procedure. SPN in the head of the pancreas or uncinate process occurs in approximately one-third of patients and is treated with a pancreatoduodenectomy. Main pancreatic-duct-unrelated small tumors can be enucleated without reducing long-term survival.[27] Technically, parenchyma-sparing surgery such as enucleations and central pancreatectomy can be applied in appropriate cases. All these surgical techniques were used in the study. Distal pancreatectomy was performed in 56.52% of the cases (13 cases) and pancreatic head resection was performed only in 5 cases (21.74%). It was seen that more limited resections such as enucleation-central pancreatectomy were used in one-fifth of the cases. No recurrence occurred in any patient, which is important to show that limited pancreatic resections can be performed in appropriate cases. Moreover, distal localized SPNs without extrapancreatic invasion constitute appropriate cases for laparoscopic surgery.[28] The laparoscopic technique was not used in any of the study cases.

The most common complication after pancreatic resections is POPF (14). POPF developed in 6 patients (26%) in the study. Since SPNs are generally distal localized, the incidence of the pancreatic fistula is more common, but they have a good prognosis. Grade B fistula developed in 4 patients who underwent distal pancreatectomy and in 1 patient who underwent central pancreatectomy. Percutaneous drainage was performed on these patients and surgical hemostasis was additionally performed on 1 patient who developed hemorrhage which solved the problem. There was no mortality in these patients. Infectious complications were observed in 5 cases (21.7%), including 1 case with superficial surgical site infection and 4 with organ space infections. Four of these had POPF and all underwent radiological or surgical intervention (Table 1).

In the study, the overall morbidity was 39.13% (n: 9 cases) and mortality was 4.34% (n: 1 case). Mortality was seen in the early postoperative period and was not associated with tumor recurrence. The median follow-up period was 53 (8–132) months; DFS was 100%; and the survival rate was 95.7%.

The only mortality in this study was in a patient who underwent enucleation due to an SPN lesion localized in the pancreatic head and developed a grade C pancreatic fistula postoperatively. This patient was initially operated on by the pediatric surgery team and underwent enucleation due to age, and then the patient was transferred to the general surgery team due to a complication that developed later. In fact, when the preoperative images of the case were evaluated, it was noticed that there was also pancreatic duct dilatation (4.2 mm). Despite repeated operations, this patient, unfortunately, died on the 39th postoperative day. Generally, in our clinic, enucleation is not a method used for pancreatic duct-associated lesions regardless of tumor size. Therefore, it is crucial to evaluate the relationship of the lesion with the pancreatic duct through preoperative radiological imaging. In the preoperative period, the localization of the lesion is clearly identified by an intraoperative ultrasound in cases of radiologically suspected or indecisive relationships with the pancreatic duct. In short, the lesion-pancreatic-duct relationship is a determining factor in the surgical decision. The size of the tumor in the other case with pancreatic duct dilatation was 3.5 cm. However, since the pancreatic duct was measured as 7 mm, the Whipple procedure was performed on this case despite the small tumor size.

Another problem with SPNs is that they can be confused with neuroendocrine tumors (NETs).[8] Specifically, the presence of abnormal nuclear expression of β-catenin, as seen in all the study patients, is widely used as a diagnostic marker. In this study, 2 cases diagnosed with NET during the examination before 2010 were found to be SPN after reexamination of the pathological specimens. In 2000, the WHO classified SPN as borderline tumors and solid pseudopapillary carcinomas showing perineural invasion, angioinvasion, or surrounding tissue invasion. However, in 2010, the WHO classified SPNs as low-grade malignant neoplasia since cases without the above-mentioned features can also metastasize. In addition, the histological subtype of SPN, which is a clinically aggressive focus of high-grade malignant transformation with increased nuclear atypia and mitotic activity, was also recently identified.[1,2] SPNs with malignant potential are metastatic lesions with a rate of 15%. In the literature, usually, a size of > 5 cm, angioinvasion, perineural invasion, surrounding tissue invasion, lymph node metastasis, cellular atypia, widespread mitosis, Ki-67 positivity, and adjacent organ involvement are defined as changes that indicate the potential for malignant behavior in SPN lesions.[6,8,11] Although studies exist in the literature that could not report a correlation between histopathological malignant changes and recurrence,[5,25,29,30] a tumor size larger than 8 cm and a stage 4 metastatic disease status were associated with recurrence in addition to these features.[4,11] Marchegianiet al., on the other hand, did not find a relationship between

tumor diameter and benign-malignant SPNs in their studies of 131 cases.[8] The prognostic role of the Ki-67 proliferative index in SPN is not clear. A Ki-67 index higher than 5% reveals the possibility of increased recurrence, but its prognostic role has not been specified.[31] In another study, it was found that a Ki-67 index >4% was associated with disease-specific survival.[32] Factors such as tumor size, nodal metastasis, and Ki-67 positivity are stated as factors that may influence recurrence in Eastern populations[32] whereas these factors are stated as lymphovascular invasion, capsular invasion, and synchronous metastases in Western populations. It is stated that this difference between Western and Eastern populations may be due to different epidemiological characteristics of SPNs.[8,26] In this study, mitosis, necrosis, and angiovascular invasion were not observed in any of the patients. Cell atypia was detected in 5 patients, perineural invasion in 4 patients, and Ki-67 of ≥ 5% in 4 patients. Cellular atypia was detected in 2 (50%) of the 4 patients with a Ki-67 proliferation index of ≥ 5% and in 3 (15.7%) of the 19 patients with a low Ki-67 proliferation index; the difference was not significant (P = .28). No recurrence was observed in any of these patients. However, the follow-up period of 4 patients with Ki-67 positivity of ≥ 5% was 12, 18, 18, and 60 months, and the follow-up period of 3 cases was much shorter than the mean follow-up period in the study. Therefore, it may be incorrect to interpret recurrence in these cases. CD10 positivity was detected in all but one of the patients whereas beta-catenin was positive in all 23 cases. The positivity of other receptors such as progesterone, chromogranin A, and synaptophysin indicated in Table 2 was highly variable and their prognostic significance could not be determined. Since none of the patients in this study had a recurrence, the histopathological prognostic criteria that affect recurrence could not be interpreted.

Since it is a low-grade malignancy and surgical resection of the tumor is the only curative option, data regarding the impact of adjuvant chemotherapy on the outcomes are limited and controversial. However, systemic multimodal treatment may be beneficial when metastatic disease is present.[33]

In conclusion, although pancreatic SPNs are rare lesions, long-term disease-free survival can be expected after curative surgery. The limitations of this study are that it was retrospective and included a limited number of patients; however, the study is significant since it demonstrated that there are no important prognostic parameters regarding tumor diameter, localization, and histopathological features in patients who were operated for SPN in our clinic. Furthermore, and considering the relationship of the pancreatic duct in the determination of the surgical strategy, it was shown that the use of a pancreatic parenchyma-protecting method does not have a negative effect on recurrence.

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References

[1] Kloppel G, Luttges J, Klimstra D. Solid-pseudopapillary neoplasm. In: Hamilton SR, Aaltonen LA, eds. World Health Organization Classification of Tumours: Pathology and Genetics of Tumours of the Digestive System. Lyon, France: IARC Press. 2000.

[2] Kloppel G, Basturk O, Klimstra DS, et al. Solid Pseudo-papillary neoplasm of the pancreas. In: Gill AJ, Klimstra DS, Lam AK, Washington MK, eds; In Who Classification of Tumors Editorial Board, eds. Tumors of pancreas. WHO Classification of Tumours. Digestive System Tumours, International Agency for Research on Cancer (IARC). 5th ed; 2019. 340–342

[3] Yu P, Cheng X, Du Y, et al. Solid pseudopapillary neoplasms of the pancreas: a-19 year multicenter experience in China. J Gastrointest Surg. 2015;19:1433–40.

[4] Zhang C, Liu F, Chang H, et al. Less aggressive surgical procedure for treatment of solid pseudopapillary tumor: limited experience from a single institute. Plus One. 2015;10:e0143452.

[5] Yağcı A, Yakan S, Coskun A, et al. Diagnosis and treatment of solid pseudopapillary tumor of the pancreas: experience of one single institution from Turkey.World J Surg Oncol. 2013;11:308.

[6] Kım JH, Lee JM. Clinicopathologic review of 31 cases of solid pseudopapillary pancreatic tumors. Can we use the scoring system of microscopik features for suggesting clinically malignant potential. Am Surg. 2016;82:308–13.

[7] Lubezky N, Papoulas M, Lessing Y, et al. Solid pseudopapillary neoplasm of the pancreas: management and long-term outcome. Eur J Surg Oncol. 2017;43:1056–60.

[8] Marchegiani G, Andrianello S, Massignani M, et al. Solid pseudopapillary tumors of the pancreas: specific pathological features predict the likelihood of postoperative recurrence. J Surg Oncol. 2016;114:597–601.

[9] Huffman BM, Westin G, Alsidawi S, et al. Survival and prognostic factors in patients with solid pseudopapillary neoplasms of the pancreas. Pancreas. 2018;47:1003–7.

[10] Hanada K, Kurihara K, Itoi T, et al. Clinical and pathological features of solid pseudopapillary neoplasms of the pancreas: a nationwide multicenter study in Japan. Pancreas. 2018;47:1019–26.

[11] Zhang H, Wang W, Yu S, et al. The prognosis and clinical characteristics of advanced (malignant) solid pseudopapillary neoplasm of the pancreas. Tumor Biol. 2016;37:5347–53.

[12] Ugras N, Yerci O, Coskun SK, et al. Retrospective analysis of clinicopathological features of solid pseudopapillary neoplasm of the pancreas. Kaohsiung J Med Sci. 2016;32:356–61.

[13] Bostancı EB, Öter V, Binarbaşı C, et al. Surgical outcomes of solid pseudopapillary neoplasm of the pancreas: a single institution's experience of 16 cases. Arch Iran Med. 2016;19:30–4.

[14] 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.

[15] Law JK, Ahmed A, Singh VK, et al. A systematic review of solid-pseudopapillary neoplasms: are these rare lesions? Pancreas. 2014;43:331–7.

[16] Kumar NAN, Bhandare MS, Chaudhari V, et al. Analysis of 50 cases of solid pseudopapillary tumor of pancreas: aggressive surgical resection provides excellent outcomes. Eur J Surg Oncol. 2019;45:187–91.

[17] Wu J, Maao Y, Jiang Y, et al. Sex differences in solid pseudopapillary neoplasm of the pancreas: a population-based study. Cancer Med. 2020;9:6030–41.

[18] Cai YQ, Xie SM, Ran X, et al. Solid pseudopapillary tumor of the pancreas in male patients: report of 16 cases. World J Gastroenterol. 2014;20:6939–45.

[19] Machado MC, Machado MA. Solid pseudopapillary neoplasm of pancreas:distinct patterns of onset, diagnosis and prognosis for male versus female patients. Surgery. 2008;143:29–34.

[20] Song H, Dong M, Zhou J, et al. Solid pseudopapillary neoplasm of the pancreas: clinicopathologic feature, risk factors of malignancy, and survival analysis of 53 cases from a sin- gle center. Biomed Res Int. 2017;2017:1–7.

[21] Hu S, Zhang H, Wang X, et al. Asymptomatic versus symptomatic solid pseudopapillary tumors of the pancreas: clini- cal and MDCT manifestations. Cancer Imaging. 2019;19:13.

[22] Sur YK, Lee JH, Kim JK, et al. Comparison of MR imaging features of solid pseudopapillary neoplasm of pancreas between male and female patients. Eur J Radiol. 2015;84:2065–70.

[23] Yu PF, Hu ZH, Wang XB, et al. Solid pseudopapillary tumor of the pancreas: a review of 553 cases in Chinese literature. World J Gastroenterol. 2010;16:1209–14.

[24] Lee SJ, Han HJ, Choi SB, et al. Surgical outcomes of solid pseudopapillary neoplasm of the pancreas: a single institution's experience fort he last years. Am Surg. 2012;78:216–9.

[25] Kim CW, Han DJ, Kim J, et al. Solid pseudopapillary tumor of the pancreas: can malignancy be predicted? Surgery. 2011;149:625–34.

[26] Serrano PE, Serra S, Al-Ali H, et al. Risk factors associated with recurrence in patients with solid pseudopapillary tumors of the pancreas. JOP. 2014;15:561–8.

[27] Coelho JCU, da Costa MAR, Ramos EJB, et al. Surgical management of solid pseudopapillary tumor of the pancreas. JSLS. 2018;22:e2018.00032.

[28] Stewart CL, Meguid C, Chapman B, et al. Evolving trends towards minimally invasive surgery for solid-pseudopapillary neoplasms. Ann Surg Oncol. 2016;23:4165–8.
[29] Liszka L, Mrowiec S, Pajak J, et al. Limited usefulness of histo-pathological features in identification of a clinically aggressive solid-pseudopapillary neoplasm of the pancreas. Pol J Pathol. 2014;65:182–93.
[30] Yang F, Jin C, Long J, et al. Solid pseudopapillary tumor of the pancreas: a case series of 26 consecutive patients. Am J Surg. 2009;198:210–5.
[31] Kim EK, Jang M, Park M, et al. LEF1, TFE3, and AR are putative diagnostic markers of solid pseudopapillary neoplasms. Oncotarget. 2017;8:93404–13.
[32] Yang F, Yu X, Bao Y, et al. Prognostic value of Ki-67 in solid pseudopapillary tumor of the pancreas: huashan experience and systematic review of the literature. Surgery. 2016;159:1023–31.
[33] Tajima H, Takamura H, Kitagawa H, et al. Multiple liver metastases of pancreatic solid pseudopapillary tumor treated with resection following chemotherapy and transcatheter arterial embolization: a case report. Oncol Lett. 2015;9:1733–8.