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Pancreatic Neuroendocrine Tumors: Our Clinical Experience and Oncological Outcomes

Pankreas Nöroendokrin Tümörler: Klinik Deneyimimiz ve Onkolojik Sonuçlarımız

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Abstract

Objectives: Pancreatic neuroendocrine tumors (pNETs) are rare neoplasms with heterogeneous clinical presentation and variable biological behavior, posing diagnostic and therapeutic challenges. The aim of this study was to evaluate the clinical characteristics, diagnostic approaches, surgical management, and oncological outcomes of patients with pNETs who were treated in our clinic and compare the results with the current literature.

Material and Methods: In this study, data from 10 patients who underwent surgery for pNET between 2018 and 2023 at the Department of General Surgery, Çukurova University Faculty of Medicine were retrospectively reviewed. Demographic characteristics, clinical presentation and symptoms, biochemical parameters, imaging findings, surgical procedures, pathological results, and 3-year postoperative follow-up data were evaluated.

Results: The mean age of the patients was 55.5 years, with equal numbers of women and men. 60% of cases were diagnosed with insulinoma, 20% with gastrinoma, and 20% with somatostatinoma. 60% of the patients presented with hypoglycemic attacks and 40% with abdominal pain. The mean tumor size was 11 mm, and the majority of tumors were located in the pancreatic head. 70% of the patients underwent a Whipple procedure, 20% underwent enucleation, and 10% underwent central pancreatectomy. Lymph node metastasis was detected in 30% of cases during the 3-year follow-up period, and one patient experienced recurrence. Analysis of the data from these patients revealed that they continued their treatment at another center. No major morbidity or mortality was observed in the postoperative period.

Conclusion: Although pNETs are rare tumors, favorable oncological outcomes can be achieved with appropriate diagnostic evaluation and timely surgical intervention. pNETs should be considered in the differential diagnosis of patients presenting with recurrent hypoglycemia or unexplained abdominal pain. Surgical management, performed in experienced centers using a multidisciplinary approach, offers effective treatment with acceptable morbidity and low recurrence rates.

Keywords: Insulinoma, gastrinoma, neuroendocrine tumor, pancreas, somatostatinoma, Whipple procedure

Öz

Giriş / Amaç: Pankreas nöroendokrin tümörleri (pNET), nadir görülmelerine rağmen heterojen klinik prezentasyonları ve değişken biyolojik davranışları nedeniyle tanı ve tedavi sürecinde zorluklar içeren neoplazmlardır. Bu çalışmada, kliniğimize hipoglisemi ve karın ağrısı ile

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başvuran pNET tanılı hastaların klinik özelliklerinin, tanısal yaklaşımlarının, cerrahi tedavi yöntemlerinin ve onkolojik sonuçlarının değerlendirilmesi ve bulguların güncel literatür ile karşılaştırılması amaçlanmıştır.

Gereç ve Yöntem: Bu çalışmada, 2018-2023 yılları arasında Çukurova Üniversitesi Tıp Fakültesi, Genel Cerrahi Anabilim Dalı'nda pNET tanısı ile opere edilen 10 hastanın verileri retrospektif olarak incelendi. Hastaların demografik özellikleri, klinik başvuru semptomları, biyokimyasal parametreleri, görüntüleme bulguları, uygulanan cerrahi prosedürler, patolojik sonuçlar ve postoperatif takip verileri değerlendirildi.

Bulgular: Hastaların ortalama yaşı 55,5 olup kadın ve erkek oranı eşitti. Olguların %60'ı insülinoma, %20'si gastrinoma ve %20'si somatostatinoma tanısı aldı. Hastaların %60'ı hipoglisemi atakları, %40'ı karın ağrısı ile prezente oldu. Ortalama tümör boyutu 11 mm idi ve tümörlerin büyük çoğunluğu pankreas baş lokalizasyonundaydı. Hastaların %70'ine Whipple prosedürü, %20'sine enükleasyon ve %10'una santral pankreatektomi uygulandı. Lenf nodu metastazı %30 oranında saptandı ve bir hastada takip sürecinde nüks gelişti. Postoperatif dönemde majör morbidite veya mortalite izlenmedi.

Tartışma / Sonuç: pNET'ler nadir tümörler olmakla birlikte, uygun tanısal yaklaşım ve zamanında cerrahi tedavi ile başarılı onkolojik sonuçlar elde edilebilmektedir. Özellikle sık hipoglisemi atakları ve açıklanamayan karın ağrısı ile başvuran hastalarda pNET olasılığı mutlaka akılda tutulmalıdır. Deneyimli merkezlerde multidisipliner yaklaşım ile uygulanan cerrahi tedavi, düşük morbidite ve kabul edilebilir nüks oranları ile etkin bir tedavi seçeneği sunmaktadır.

Anahtar Kelimeler: İnsülinoma, gastrinoma, nöroendokrin tümörü, pankreas, somatostatinoma, Whipple prosedürü

Introduction

Pancreatic neuroendocrine tumors (pNETs) are a heterogeneous group of neoplasms originating from pancreatic islet cells and account for approximately 1-2% of all pancreatic tumors; however, they represent the second most common type of rare solid pancreatic neoplasms (1). According to the World Health Organization (WHO), the annual incidence of pNETs is reported to be 0.48 per 100.000 individuals (2).

These tumors arise from hormone-producing cells and are clinically classified as functional or non-functional. Functional pNETs include insulinoma, gastrinoma, glucagonoma, VIPoma, and somatostatinoma. The clinical manifestations of functional tumors result from excessive hormone secretion; therefore, hormonal assays play a critical role in both diagnosis and follow-up. Non-functional pNETs are not associated with hormonal syndromes and usually present at advanced stages with non-specific symptoms such as abdominal pain, weight loss, or mass effect (2,3).

pNETs may occur sporadically or in association with hereditary syndromes such as multiple endocrine neoplasia type 1. However, the molecular pathogenesis of these tumors has not yet been fully elucidated. Various imaging modalities are used for tumor localization, including ultrasonography, computed tomography, magnetic resonance imaging, endoscopic ultrasonography, selective arterial catheterization with hepatic venous sampling, octreotide scintigraphy, and DOTA-TATE peptide positron emission tomography (3,4).

Most pNETs present as solitary, well-circumscribed, contrast-enhancing solid masses arising in a specific region of the pancreas. Although most tumors exhibit slow growth, they possess malignant potential. Tumor stage, lymph node involvement, distant metastasis, and tumor size are significant prognostic factors affecting survival. An aggressive treatment strategy, consisting of surgery, local treatment, systemic therapy, and management of complications, is recommended (4,5).

The aim of this study was to evaluate the clinical characteristics, diagnostic approaches, surgical treatments, and oncological outcomes in patients with pNETs and compare the findings with the current literature.

Materials and Methods

This retrospective study was conducted in accordance with the principles of the Declaration of Helsinki. The study was approved by the Ethics Committee of Çukurova University Faculty of Medicine (approval no: 22, date: 09.01.2026).

Patients who underwent surgery for a pNET at the Department of General Surgery, Çukurova University Faculty of Medicine, between 2018 and 2023 were included in the study. Patient data were obtained from the hospital's electronic medical record system.

Inclusion criteria were age ≥18 years and availability of complete clinical, laboratory, radiological, and pathological data. Patients under 18 years of age, those with incomplete hospital records, and those whose examinations, performed at external centers, could not be accessed were excluded from the study.

Patients were classified into three groups according to diagnosis: insulinoma (n=6), gastrinoma (n=2), and somatostatinoma (n=2).

In our study, in which median values were used due to the small sample size, laboratory findings and radiological examinations, such as ultrasonography, endoscopic ultrasonography, computed tomography, magnetic resonance imaging, and positron emission tomography, were evaluated preoperatively

in symptomatic or incidentally detected pNET cases. Data on the treatment received by patients in the preoperative period were also included in the study.

Postoperative follow-up data included: hormone levels, pathological examination results, early and late complications, surgical methods, length of hospital stay, recurrence status, and need for additional medical treatment.

Demographic characteristics and preoperative laboratory parameters, including white blood cell count, hemoglobin, hematocrit, platelet count, C-reactive protein, insulin, C-peptide, glucose, and HbA1c levels, were recorded.

Statistical Analysis

All collected data were recorded, median values were calculated, and the results were compared with extensive studies in the literature.

Results

The mean age of the 10 patients included in the study was 55.5 years. Five patients (50%) were male and five (50%) were female. According to the distribution of diagnoses, 60% (n=6) of the patients were diagnosed with insulinoma, 20% (n=2) with gastrinoma, and 20% (n=2) with somatostatinoma.

Four patients (40%) presented with abdominal pain, while six patients (60%) presented with hypoglycemic attacks. All patients who presented with hypoglycemia were diagnosed with insulinoma. Among patients presenting with abdominal pain, two were diagnosed with gastrinoma and two with somatostatinoma.

In patients diagnosed with insulinoma, the mean insulin level at presentation was 10.17 µU/mL (0.91-21.21), the mean C-peptide level was 3.53 ng/mL (2.37-5.72), and the mean glucose level was 107.6 mg/dL (49-146).

Pancreaticoduodenectomy (Whipple procedure) was performed in seven patients (70%), enucleation in two (20%), and central pancreatectomy in one (10%).

The mean tumor size was 11 mm (10-15 mm). Tumors were localized in the pancreatic head in eight patients (80%), in the periampullary region in one patient (10%), and in the pancreatic uncinate process in one patient (10%).

Lymph node metastasis was detected in three patients (30%), but not in seven patients (70%). During follow-up, recurrence occurred in one patient who had lymph node metastasis. No major postoperative morbidity or mortality was observed.

Discussion

Despite their rarity, pNETs are clinically important because of their diverse presentation, biological behavior, and treatment strategies. In large series reported in the literature, the median age of patients diagnosed with pNETs has been reported to range between 50 and 60 years (1,3). The mean age in our study was 55.5 years, which is consistent with these reports. Gender has not been shown to influence the incidence of pNETs (4), and a similar distribution was observed in our cohort.

Among functional pNETs, insulinoma is the most frequently reported subtype in the literature (5). Recent studies have emphasized insulinoma as the predominant functional pNET subtype (6). In our study, insulinomas accounted for 60% of cases, consistent with published data.

Placzkowski et al. (7) reported that patients with insulinoma commonly present with neuroglycopenic hypoglycemic symptoms and that hypoglycemia is a highly specific clinical finding for insulinoma. All patients presenting with hypoglycemia in our study were diagnosed with insulinoma, which supports this observation.

Other functional pNET subtypes, such as gastrinoma and somatostatinoma, often present with non-specific symptoms (8). Garbrecht et al. (9) reported that somatostatinomas frequently present with abdominal pain, weight loss, and diarrhea. In our study, all patients diagnosed with gastrinoma or somatostatinoma presented with abdominal pain.

Although pNETs may arise in any region of the pancreas, several studies have reported a predominance in the pancreatic head (10). In our cohort, 80% of tumors were located in the pancreatic head, which explains the high rate of pancreaticoduodenectomy.

Surgical resection remains the cornerstone of curative treatment in localized pNETs. Enucleation is recommended for small, well-demarcated, low-grade tumors, whereas formal pancreatic resection is preferred for larger tumors or those with malignant potential (11). The surgical approaches applied in our study are consistent with these recommendations.

Lymph node metastasis is considered one of the most important prognostic factors in pNETs and is emphasized in the WHO 2022 classification (2). In our study, lymph node metastasis was detected in 30% of patients, and recurrence occurred only in patients with nodal involvement.

The absence of major postoperative morbidity and mortality in our study demonstrates that surgical treatment of pNETs can be performed safely in experienced centers.

Study Limitations

This study has several limitations. First, its retrospective design, based on data obtained from existing medical records, carries a risk of missing data and selection bias. In addition, the limited number of patients reduces the statistical power of subgroup comparisons and restricts the generalizability of the findings. Furthermore, since the study reflects the experience of a single center, the results may not be directly applicable to other institutions or broader populations.

Moreover, the relatively short follow-up period in some patients may have limited the evaluation of long-term recurrence and survival outcomes. Another limitation is the lack of routine molecular and genetic analyses, which restricts a more detailed assessment of prognostic factors. Future multicenter, prospective studies with larger patient populations may provide stronger evidence and more generalizable results.

Conclusion

pNETs, though rare, require careful consideration during diagnosis and treatment because of their heterogeneous clinical presentations and variable biological behavior. Our retrospective clinical experience in this study, covering patients who were operated on between 2018 and 2023 and followed for three years, supports the conclusion that the diagnostic and surgical treatment approaches for pNETs are consistent with the literature and are effective.

Insulinomas presenting with hypoglycemic attacks facilitate an early and specific diagnosis; however, in other functional subtypes, such as gastrinoma and somatostatinoma, non-specific symptoms can lead to delayed diagnosis. In localized pNETs, surgical treatment is the cornerstone of curative management. Surgery planned according to tumor size, location, and lymph node involvement provides successful oncological outcomes with low recurrence rates and acceptable morbidity. These findings demonstrate that evaluation of pNETs at experienced centers with a multidisciplinary approach, appropriate patient selection, and timely surgical intervention are crucial to achieving curative results.

Ethics

Ethics Committee Approval: The study was approved by the Ethics Committee of Çukurova University Faculty of Medicine (approval no: 22, date: 09.01.2026).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Concept/Design: E.U., İ.A., A.T.A., Data Collection or Processing: E.U., İ.C.Y., İ.A., A.Ü., A.T.A., Analysis or Interpretation: E.U., Y.K., A.G.S., A.T.A., Literature Review: İ.C.Y., Writing, Reviewing and Editing: E.U., İ.C.Y., Y.K., A.T.A.

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References

1. Milan SA. and Yeo CJ. Neuroendocrine tumors of the pancreas. Curr Opin Oncol. 2012;24:46-55.
2. Yao JC, Hassan M, Phan A, et al. One hundred years after "carcinoid": epidemiology of and prognostic factors for neuroendocrine tumors in 35,825 cases in the United States. J Clin Oncol. 2008;26:3063-72.
3. Batcher E, Madaj P, Gianoukakis AG. Pancreatic neuroendocrine tumors. Endocr Res. 2011;36:35-43.
4. Ro C, Chai W, Yu VE, Yu R. Pancreatic neuroendocrine tumors: biology, diagnosis, and treatment. Chin J Cancer. 2013;32:312-24.
5. Müssig K, Dudziak K, Horger M, Anlauf M, Goretzki PE. Diagnosis and therapy of functional pancreatic neuroendocrine tumors. Dtsch Med Wochenschr. 2011;136:1319-30.
6. Bahou K, Achour Y, Ilahiane M, et al. Diagnosis and management of benign secreting pancreatic insulinoma: what's new? 4 case report. Rare Tumors. 2025;17:20363613241313409.
7. Placzkowski KA, Vella A, Thompson GB, et al. Secular trends in the presentation and management of functioning insulinoma. J Clin Endocrinol Metab. 2009;94:1069-73.
8. Ito T, Igarashi H, Jensen RT. Pancreatic neuroendocrine tumors: clinical features, diagnosis and medical treatment: advances. Best Pract Res Clin Gastroenterol. 2012;26:737-53.
9. Garbrecht N, Anlauf M, Schmitt A, et al. Somatostatin-producing neuroendocrine tumors of the duodenum and pancreas: incidence, types, biological behavior, association with inherited syndromes, and functional activity. Endocr Relat Cancer. 2008;15:229-41.
10. Norton JA. Surgical treatment and prognosis of gastrinoma. Best Pract Res Clin Gastroenterol. 2005;19:799-5.
11. Norton JA, Fraker DL, Alexander HR, Jensen RT. Value of surgery in patients with negative imaging and sporadic Zollinger-Ellison syndrome. Ann Surg. 2012;256:509-17.