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Clinical Characteristics, Surgical Management, and Outcomes of Appendiceal Neoplasms: Retrospective Study of 35 Cases

Apendiks Neoplazmlarının Klinik Özellikleri, Cerrahi Yönetimi ve Sonuçları: 35 Olgunun Retrospektif İncelemesi

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ABSTRACT Objective: Appendiceal neoplasms are rare, present diagnostic challenges due to nonspecific symptoms resembling acute appendicitis. This study aims to evaluate the clinical characteristics, diagnostic accuracy, surgical management, long-term outcomes of patients with appendiceal neoplasms who underwent appendectomy. **Material and Methods:** A retrospective analysis was conducted on 35 patients diagnosed with appendiceal neoplasms from a cohort of 3,361 appendectomy cases at the Haydarpaşa Numune Training and Research Hospital between 2013-2023. Data on demographics, preoperative imaging, intraoperative findings, histopathological results, surgical interventions, and follow-up outcomes were analyzed. **Results:** Of the 35 patients, 19 (54.3%) were female, and 16 (45.7%) were male, with a mean age of 42.7 years. The most common diagnosis was appendix neuroendocrine tumor (57.1%), followed by mucinous neoplasms and colonic-type adenocarcinomas. None of the neoplastic cases were diagnosed preoperatively. Laparoscopic appendectomy was performed in 14.3% of cases, with the remaining patients undergoing open surgery. Right hemicolectomy was required in 7 (20%) cases. Postoperative colonoscopy was performed for all patients, with adenocarcinoma cases enrolled in colorectal cancer follow-up programs. During the follow-up period, 2 (5.7%) patients died of advanced disease, while the remaining patients showed good long-term survival, with a mean follow-up of 59 months. **Conclusion:** Although appendiceal neoplasms are rare, they present significant diagnostic and management challenges. Early detection is difficult, but appropriate surgical management and rigorous follow-up, particularly for adenocarcinoma cases, are crucial for improving outcomes. Advancements in imaging and molecular diagnostics may improve preoperative detection in the future.

Keywords: Appendiceal neoplasms; neuroendocrine tumor; mucinous neoplasms; adenocarcinoma; appendectomy

ÖZET Amaç: Apendiks neoplazmları, nadir görülür ve akut apandisite benzeyen özgün olmayan semptomları nedeniyle tanısal zorluklar oluşturur. Bu çalışma, apendektomi uygulanan apendiks neoplazmı hastalarının klinik özelliklerini, tanısal doğruluğunu, cerrahi yönetimini ve uzun dönem sonuçlarını değerlendirmeyi amaçlamaktadır. **Gereç ve Yöntemler:** Haydarpaşa Numune Eğitim ve Araştırma Hastanesinde, 2013-2023 yılları arasında gerçekleştirilen 3.361 apendektomi olgusu arasından apendiks neoplazmı tanısı alan 35 hasta retrospektif olarak incelendi. Hastaların demografik verileri, preoperatif görüntüleme yöntemleri, intraoperatif bulguları, histopatolojik sonuçları, cerrahi girişimleri ve takip sonuçları analiz edildi. **Bulgular:** Otuz beş hastanın 19'u (%54,3) kadın, 16'sı (%45,7) erkek olup; yaş ortalaması 42,7 idi. En sık görülen histopatolojik tanı apendiks nöroendokrin tümörü (%57,1) olup, bunu müsinöz neoplazmlar ve kolon tipi adenokarsinomlar izledi. Preoperatif dönemde, hiçbir olgu doğru şekilde neoplastik apandisit tanısı almadı. Hastaların %14,3'üne laparoskopik apendektomi, geri kalanına ise açık cerrahi uygulandı. Yedi (%20) hastada sağ hemikolektomi gerekli görüldü. Tüm hastalara postoperatif kolonoskopi uygulandı ve adenokarsinom olguları, kolorektal kanser takip programına dâhil edildi. Takip sürecinde 2 (%5,7) hasta ileri hastalık nedeniyle yaşamını yitirirken, diğer hastalarda ortalama 59 aylık takip süresi boyunca iyi uzun dönem sağkalım gözlendi. **Sonuç:** Apendiks neoplazmları, nadir görülmekle birlikte tanı ve tedavi açısından önemli zorluklar sunar. Erken tanı genellikle zordur, ancak uygun cerrahi müdahale ve özellikle adenokarsinom olgularında titiz takip, hasta sonuçlarını iyileştirmede kritik öneme sahiptir. Görüntüleme ve moleküler tanı yöntemlerindeki ilerlemeler, gelecekte preoperatif tanıyı iyileştirebilir.

Anahtar Kelimeler: Apendiks neoplazmları; nöroendokrin tümör; müsinöz neoplazmlar; adenokarsinom; apendektomi

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Acute appendicitis is one of the most common causes of abdominal emergencies, with appendectomy being the standard treatment. Despite the high frequency of appendectomies performed worldwide, the incidence of neoplastic lesions within the appendix remains relatively low, varying between 0.5-2% in surgical series.[1] However, the discovery of appendix neoplasms, especially in cases diagnosed preoperatively as acute appendicitis, has drawn increased attention due to their unique clinical and pathological characteristics.[2] Among the various histopathological types, appendix neuroendocrine tumors (ANET), mucinous neoplasms, and colonic-type adenocarcinomas represent the majority of malignant lesions detected in the appendix.[3]

ANET are the most common neoplasms of the appendix and are generally associated with a favorable prognosis when detected at an early stage.[4] In contrast, mucinous neoplasms, including low-grade appendiceal mucinous neoplasia and mucinous adenocarcinoma, tend to present diagnostic and therapeutic challenges due to their potential for peritoneal dissemination, which can lead to pseudomyxoma peritonei.[5] Colonic-type adenocarcinoma of the appendix, while rare, behaves similarly to colorectal cancer and requires tailored management strategies, including right hemicolectomy and enrollment in colorectal cancer follow-up protocols.[6]

Preoperative diagnosis of appendiceal neoplasms is often difficult due to the nonspecific nature of symptoms, which usually mimic acute appendicitis. Radiological imaging methods, such as ultrasonography (USG) and computed tomography (CT), play a crucial role in diagnosing acute appendicitis, but their sensitivity and specificity in detecting neoplastic lesions of the appendix remain limited.[7] Most cases of appendiceal neoplasms are diagnosed incidentally during surgery or upon histopathological examination of the resected appendix.[8]

The appropriate surgical approach to appendiceal neoplasms depends on the tumor type, size, and stage at the time of diagnosis. While simple appendectomy is sufficient for small ANETs, larger tumors or those with more aggressive histopathological features often necessitate a more extensive resection, such as right hemicolectomy.[9] Similarly, appendectomy alone may be insufficient for mucinous neoplasms and colonic-type adenocarcinomas, where more comprehensive surgical interventions and postoperative oncological management are warranted.[10,11]

Given the potential for synchronous colorectal tumors in patients with appendiceal adenocarcinoma, routine colonoscopy following the diagnosis of these malignancies is crucial for early detection and appropriate treatment.[12,13] Furthermore, long-term follow-up protocols for patients with appendiceal adenocarcinoma are aligned with colorectal cancer surveillance programs, emphasizing the importance of comprehensive management.[14,15]

The aim of this study was to evaluate the clinical characteristics, radiological findings, intraoperative observations, histopathological types, and treatment outcomes of 35 patients with appendiceal neoplasms detected among 3,361 appendectomy cases performed at the Haydarpaşa Numune Training and Research Hospital between 2013-2023. We conducted a retrospective analysis of these cases to determine the frequency and types of appendiceal neoplasms, the accuracy of preoperative diagnosis, and the postoperative management strategies implemented. Additionally, we aimed to assess the follow-up outcomes and survival rates of patients with different histopathological types of appendiceal neoplasms over an extended follow-up period.

MATERIAL AND METHODS

A total of 3,361 patients diagnosed with acute appendicitis underwent appendectomy at the Haydarpaşa Numune Training and Research Hospital between 2013-2023. Histopathological evaluation of the appendectomy specimens identified ANET, mucinous neoplasms, and appendix colonic-type adenocarcinomas in 35 patients.

A retrospective analysis was conducted using a database that included detailed information on patient age, gender, preoperative radiological imaging methods, intraoperative findings, tumor histopathology, tumor size and grade, histopathological staging, postoperative treatment management, follow-up protocols, and disease survival.

In the postoperative period, all patients underwent colonoscopy in the general surgery endoscopy unit to rule out synchronous colon tumors. Patients diagnosed with adenocarcinoma were included in the colorectal cancer follow-up program according to established protocols.

Since this study was conducted retrospectively, informed consent was not obtained from the patients. The data were collected through a review of records from the hospital's electronic system.

The study was approved by the Ethics Committee of Haydarpaşa Numune Training and Research Hospital, with the approval number 770/06/2020, issued in June 20, 2020 and which was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Between 2013-2023, appendix neoplasms were detected in 35 (1.04%) of 3,361 appendectomy cases. The age range of these 35 patients was 23 to 81 years, with a mean age of 42.7. The gender distribution was 19 (54.3%) women and 16 (45.7%) men. A total of 10 (28.5%) patients were aged 50 or older. All patients underwent emergency surgery under general anesthesia. Laparoscopic surgery was performed in 5 (14.3%) patients, while the remaining patients underwent conventional surgery. The classic McBurney incision was used for open appendectomy in these patients.

In the preoperative period, 13 patients were diagnosed with acute appendicitis using only USG, 12 patients using only CT, and 10 patients via a combination of both USG and CT. However, no case of neoplastic appendicitis was correctly diagnosed preoperatively.

Intraoperative findings revealed that catarrhal appendicitis was the most common observation, present in 20 (57.1%) of the appendix neoplasms. In histopathological evaluation, the most common neoplasm identified was ANET, accounting for 57.1% of cases.

The case distribution of appendix neoplasms and intraoperative findings are shown in Table 1. Postoperatively, all patients were discharged without complications after an average hospital stay of 2.8 days. The average response time for pathology reports was 24 days. In 7 (20%) cases, a secondary surgery involving right hemicolectomy was performed (1 ANET, 2 mucinous adenocarcinomas, and 4 appendiceal colonic-type adenocarcinomas), while appendectomy was sufficient in the remaining 28 cases.

TABLE 1: Case distribution of appendix neoplasia and intraoperative findings

Appendix neoplasia Intraoperative finding n (%)	n (%)	Incidence (%)
ANET		
Catarrhal 16 (80)		
Perforated 2 (10)	20 (57.1)	0.59
Plastrone 2 (10)		
Low grade mucinous neoplasia		
Catarrhal 3 (33)		
Plastrone 1 (22)	9 (25.7)	0.27
Mucocele 5 (55)		
Mucinous adenocarcinoma		
Plastrone 2 (100)	2 (5.7)	0.06
Colonic type appendix adenocarcinoma		
Catarrhal 1 (25)		
Perforated 1 (25)	4 (11.5)	0.12
Plastrone 2 (50)		

ANET: Appendix neuroendocrine tumor

In this study, most ANET were small and low-grade (Table 2). Specifically, 70% of tumors were ≤1 cm in diameter, treated solely with appendectomy, while 25% measured between 1-2 cm and were also managed by appendectomy alone. Only 5% of tumors were >2 cm, requiring a secondary right hemicolectomy following initial appendectomy. Histopathological evaluation revealed that 95% of cases were Grade I (Ki-67 index ≤2%) according to the World Health Organization (WHO)-2010 classification, indicating a low proliferation rate, while 5% were Grade II (Ki-67 index 3-20%). According to the European Neuroendocrine Tumor Society (ENETS) tumor-node-metastasis (TNM) staging guidelines, 70% of ANETs were staged as T1N0M0, 25% as T2N0M0, and 5% as T3N0M0, highlighting that most tumors were localized and at an early stage.

Following histopathological diagnosis, total colonoscopy was performed on all patients in our

TABLE 2: Histopathological characters and operations performed in ANETs

n (%)	Tumor diameter	Surgery performed	Seconder operation
14 (70)	≤1 cm	Appendectomy	-
5 (25)	1-2 cm	Appendectomy	-
1 (5)	>2 cm	Appendectomy	Right hemicolectomy
Ki-67 Proliferative Index and WHO-2010 Tumor Grade Classification			
Grade	**Ki-67 Proliferative Index**	**n (%)**	
Grade I	≤2%	19 (95)	
Grade II	3-20%	1 (5)	
TNM staging according to the ENETS Guidelines			
TNM	**n (%)**		
T1NOMO	14 (70)		
T2NOMO	5 (25)		
T3NOMO	1 (5)		

ANET: Appendix neuroendocrine tumor; WHO: World Health Organization; TNM: Tumor-node-metastasis; ENETS: European Neuroendocrine Tumor Society

general surgery endoscopy unit to screen for possible synchronous colon tumors. Postoperative follow-up of patients with adenocarcinoma (mucinous and colonic-type adenocarcinomas) was conducted according to colorectal cancer follow-up protocols.

During the follow-up period, patient survival ranged between 22-113 months. Two (5.7%) patients-1 with ANET and 1 with colonic-type adenocarcinoma-died during this time, while the remaining patients are still alive.

In this study, several cases of appendix colonic-type adenocarcinoma demonstrated specific pathological findings and surgical approaches (Table 3). Four cases were identified, with intraoperative findings of plastron (cases 1 and 3), catarrhal (case 2), and perforation (case 4). Each case initially underwent an appendectomy, followed by a secondary right hemicolectomy. Pathological analysis post-hemicolectomy revealed no residual tumor in cases 1, 2, and 4, while case 3 showed advanced staging (T3N2), indicating lymph node involvement. These results underscore the importance of secondary surgery in managing high-risk adenocarcinoma cases.

The pathological staging (TNM) of ANET cases was conducted according to the Tumor Grade Classification (WHO-2010), following the recommendations of the ENETS. Mucinous neoplasms, including low-grade appendiceal mucinous neoplasia and appendiceal mucinous adenocarcinoma, were assessed using the 2016 Modified Delphi Consensus Protocol (Delphi) and the 8th edition of the American Joint Committee on Cancer. Colonic-type adenocarcino-

TABLE 3: Pathological findings and surgical treatment modalities

Appendix colonic type adenocarcinoma	Intraoperative finding	Surgical procedure	Seconder surgery	Pathology
Case 1 T3NXMX	Plastrone	Appendectomy	Right hemicolectomy	No residual tumor
Case 2 T1NXMX	Catarrhal	Appendectomy	Right hemicolectomy	No residual tumor
Case 3 T3NXMX	Plastrone	Appendectomy	Right hemicolectomy	T3N2
Case 4 T3NXMX	Perforated	Appendectomy	Right hemicolectomy	No residual tumor

mas were staged according to the TNM classification from the American Joint Committee on Cancer 8th edition.

DISCUSSION

Appendiceal neoplasms, though rare, represent a distinct pathological entity that poses significant diagnostic and therapeutic challenges. Our study, focusing on 35 cases of appendiceal neoplasms identified from a cohort of 3,361 appendectomy cases, adds to the growing body of evidence on the clinical management and outcomes of these tumors. One of the critical findings in our study is the predominance of ANET, followed by mucinous neoplasms and colonic-type adenocarcinomas, consistent with current literature that highlights the relatively high incidence of ANET among appendiceal neoplasms, as ANET typically carries a better prognosis compared to other malignancies, provided that early detection and appropriate surgical management are achieved.

The accurate preoperative diagnosis of appendiceal neoplasms remains a significant challenge, as demonstrated by the fact that no case of neoplastic appendicitis was correctly identified preoperatively in our study. This finding underscores the difficulty of distinguishing neoplastic appendicitis from simple acute appendicitis based on clinical symptoms and standard imaging techniques such as USG and CT. Recent advances in imaging modalities, such as contrast-enhanced CT and magnetic resonance imaging, have been shown to improve diagnostic accuracy; however, these techniques are not routinely employed in acute settings due to time constraints and limited availability.[16] Studies have suggested that radiological findings such as thickening of the appendiceal wall, periappendiceal fat stranding, and the presence of a mass should raise suspicion for neoplastic appendicitis.[17] In our cohort, radiological evaluation predominantly suggested acute appendicitis, and the neoplastic nature of the lesions was only confirmed postoperatively, highlighting the need for more nuanced diagnostic protocols in the future.

Surgical management of appendiceal neoplasms is guided by tumor size, type, and stage. In our study, most patients underwent conventional open surgery, with only a small proportion undergoing laparoscopic appendectomy. This preference for open surgery may be influenced by concerns regarding the potential for tumor spillage and inadequate resection margins in laparoscopic procedures, particularly in cases of mucinous neoplasms and adenocarcinomas.[18] The role of laparoscopic surgery in the management of appendiceal neoplasms remains controversial, with some studies advocating for its safety and efficacy in selected cases.[19] However, for tumors larger than 2 cm or those with invasive features, right hemicolectomy is generally recommended due to the increased risk of lymph node involvement and metastasis.[20] In our study, right hemicolectomy was performed in selected cases, consistent with current guidelines that advocate for more extensive resection in cases of mucinous adenocarcinoma and colonic-type adenocarcinoma.[21]

One of the key points in the management of appendiceal neoplasms is the follow-up protocol, especially for patients with adenocarcinoma. In our series, all patients diagnosed with adenocarcinoma were enrolled in a colorectal cancer surveillance program, which includes regular colonoscopy and imaging to detect recurrence or synchronous tumors.[22] The rationale behind this approach is the high rate of synchronous colorectal tumors in patients with appendiceal adenocarcinoma, as highlighted by recent studies that report an incidence of synchronous colorectal malignancies as high as 20%.[23] In our study, no synchronous colorectal tumors were detected, but this finding does not diminish the importance of rigorous follow-up in these patients.

The prognosis of patients with appendiceal neoplasms varies significantly depending on the histopathological subtype. ANETs, particularly those smaller than 2 cm and confined to the appendix, are associated with excellent long-term survival, with 5-year survival rates exceeding 90%.[24] In contrast, mucinous adenocarcinomas and colonic-type adenocarcinomas are more aggressive, with 5-year survival rates ranging from 30% to 60% depending on the stage at diagnosis.[25] In our study, the survival outcomes were consistent with these figures, with only 2 deaths recorded during the follow-up period,

both in patients with aggressive histological subtypes (ANET and colonic-type adenocarcinoma). This highlights the importance of early detection and appropriate surgical intervention, particularly in cases of adenocarcinoma.

The importance of histopathological staging cannot be overstated in determining the prognosis and treatment strategy for appendiceal neoplasms. In our study, the TNM staging system was used for adenocarcinomas, while ANETs were staged according to the WHO-2010 classification.[26] Accurate staging not only informs the need for further surgical interventions, such as right hemicolectomy, but also guides the postoperative follow-up and adjuvant treatment plans. Recent advancements in molecular profiling and the identification of specific genetic mutations associated with appendiceal neoplasms may further refine staging and treatment in the future.[27]

Another critical aspect of managing appendiceal neoplasms is the decision regarding adjuvant chemotherapy. Current guidelines suggest that adjuvant chemotherapy is not routinely indicated for ANETs due to their typically indolent nature, but it is recommended for high-grade mucinous neoplasms and colonic-type adenocarcinomas.[28] In our cohort, none of the patients with ANETs received adjuvant therapy, while those with adenocarcinoma were managed according to colorectal cancer treatment protocols, which include adjuvant chemotherapy for stage II and III disease. This approach is supported by several studies demonstrating improved overall survival with adjuvant therapy in these patients.[27]

Our study has several limitations, including its retrospective design and the relatively small sample size. These limitations may introduce bias in the selection and management of patients, and future prospective studies with larger cohorts are needed to confirm our findings. Additionally, the lack of preoperative suspicion for neoplastic appendicitis in our series raises questions about the adequacy of current diagnostic algorithms, suggesting the need for more sophisticated imaging and laboratory techniques to improve preoperative diagnosis.

CONCLUSION

Appendiceal neoplasms, though rare, present a unique clinical challenge due to their varied histopathological types and unpredictable behavior. Our study highlights the importance of early detection, appropriate surgical management, and rigorous postoperative follow-up, particularly for patients with aggressive subtypes such as mucinous and colonic-type adenocarcinomas. Advances in diagnostic imaging, molecular profiling, and tailored adjuvant therapies are likely to improve outcomes for these patients in the future.

MAIN POINTS

1. Appendiceal neoplasms are rare and difficult to diagnose preoperatively, often mimicking acute appendicitis.

2. In this study, ANET were the most common type of appendiceal neoplasm, accounting for 57.1% of cases.

3. Preoperative imaging, including USG and CT, failed to accurately diagnose any cases of neoplastic appendicitis.

4. Laparoscopic surgery was performed in a small number of cases, while right hemicolectomy was required in 20% of patients due to aggressive histopathological subtypes.

5. Postoperative colonoscopy is essential in adenocarcinoma cases to screen for synchronous colorectal tumors and ensure appropriate follow-up.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mehmet Torun;* ***Design:*** *Mehmet Torun, Erkan Özkan;* ***Control/Supervision:*** *Meryem Günay Gürleyik;* ***Data Collection and/or Processing:*** *Fügen Vardar Aker, Mehmet Torun;* ***Analysis and/or Interpretation:*** *Erkan Özkan;* ***Literature Review:*** *Aylin Gönültaş;* ***Writing the Article:*** *Mehmet Torun, Erkan Özkan;* ***Critical Review:*** *Meryem Günay Gürleyik;* ***Materials:*** *Aylin Gönültaş.*

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