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RESEARCH ARTICLE

Microbiological Testing and Antibiotic Resistance in Patients Undergoing Drainage for Perianal Abscess: A Retrospective Observational Cohort Study

Sümeyra Emine Bölük[1], Salih Bölük[2], Yahya Kaan Karatepe[3], Zafer Şenol[1]

[1]University of Health Sciences Türkiye, Sultan 2. Abdul Hamid Khan Training and Research Hospital, Clinic of General Surgery, İstanbul, Türkiye
[2]Gebze Medical Park Hospital, Clinic of General Surgery, Kocaeli, Türkiye
[3]Elbistan State Hospital, Clinic of General Surgery, Kahramanmaraş, Türkiye

ABSTRACT

Aim: Despite the widespread use of empiric antibiotics, the role of routine microbiological testing in patients with perianal abscesses to guide treatment remains uncertain. This study aimed to assess the rate of microbiological testing, the spectrum of pathogens identified, and their antibiotic resistance profiles in patients who underwent surgical drainage of perianal abscess.

Method: A single-center retrospective study was conducted on 141 adult patients who underwent incision and drainage for perianal abscesses between January 2017 and March 2024. The attending surgeon decided whether to obtain intraoperative bacteriological culture samples. Clinical characteristics, culture results, and antibiotic resistance profiles were analyzed.

Results: Microbiological testing was performed in 32.6% of patients. Bacterial isolates were detected in 63.0% of the tested patients, with *Escherichia coli (E. coli) (52.2%)* and *Klebsiella pneumoniae (K. pneumoniae)* (10.8%) being the most frequently isolated bacteria. Antibiotic resistance rates were high, particularly for *E. coli*, with resistance to ampicillin (81.4%) and cefazolin (75.0%) being the most common. No resistance was observed to amikacin, colistin, or carbapenems. At a median follow-up of 93 days, 68.8% of the patients reported no sequelae, whereas 19.9% required further surgical intervention for perianal fistula.

Conclusion: The results suggest that a considerable portion of perianal abscess cases harbor resistant pathogens, particularly *E. coli* and *K. pneumoniae*. Given the high rates of antibiotic resistance observed, routine microbiological testing may help guide targeted antibiotic therapy, especially in patients with complex or recurrent abscesses. Although microbiological testing revealed high resistance rates among common pathogens, the findings must be interpreted cautiously, given the retrospective design, limited use of microbiological testing, absence of anaerobic cultures, and delayed result availability.

Keywords: Perianal glands, abscess, aerobic bacteria, Escherichia coli, Klebsiella pneumoniae, antibacterial drug resistance

Introduction

A perianal abscess is an acute suppurative infection of the soft tissue surrounding the rectum and anus.[1] It is a common condition encountered in emergency general surgery.[2] The primary underlying cause is the inflammation of the anal glands at the base of the anal crypts, a condition known as cryptoglandular origin.[3,4] Systemic infection or life-threatening sepsis may occur, notably in elderly patients or those with compromised immune systems.[1] Although timely drainage of the abscess is the most effective treatment modality, empiric antibiotic treatment, regardless of culture results, is usually recommended to control cellulitis, systemic illness, or underlying immunosuppression. Depending on the

Address for Correspondence: Sümeyra Emine Bölük MD, University of Health Sciences Türkiye, Sultan 2. Abdul Hamid Khan Training and Research Hospital, Clinic of General Surgery, İstanbul, Türkiye
E-mail: smyra_3@hotmail.com **ORCID ID:** orcid.org/0000-0001-8415-6755
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localization, a perianal fistula is the major complication of a perianal abscess.[1,2]

The most common pathogens detected in patients with perianal abscesses include a mix of aerobic and anaerobic gut microbiota, such as *Escherichia coli (E. coli), Proteus vulgaris,* and *Staphylococcus aureus,* as well as *Streptococcus, Bacteroides*, and *Peptostreptococcus* species.[1,3,5] However, conventional culture-based diagnostic techniques may be limited in covering the full microbial spectrum in such infections.[1] Additionally, antimicrobial drug resistance has been increasingly reported.[6,7] Despite these concerns, there is ongoing debate regarding the utility of routine microbiological testing, particularly in uncomplicated abscesses, where empirical management is often sufficient, outcomes are generally favorable, and culture data rarely alter immediate management in straightforward cases. Given these limitations, several authors have questioned the need for routine microbiological examination of pus swabs from uncomplicated perianal abscesses.[7-9] Although some earlier studies suggested a link between gut microbiota in perianal abscess cavities and subsequent fistula development, more recent evidence does not consistently support this association.[9,10] Consequently, according to the drainage culture test results, the optimum antibiotic regimens remain speculative.[7,9,11]

This study primarily aimed to determine the rate of microbiological testing, describe the microbiological and resistance profile of perianal abscesses in a surgical cohort, and assess potential implications for empirical antibiotic choice.

Materials and Methods

Study

A single-center retrospective, observational cohort study was conducted on patients who underwent surgical treatment with incision and drainage for perianal abscesses in the general surgery clinics of a tertiary referral center in İstanbul, Türkiye, between January 2017 and March 2024. The local ethics committee of University of Health Sciences Hamidiye Scientific Research Ethics Committee approved the study (approval number: 2/26, dated: 16.02.2024) which adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was waived due to the study's retrospective design and the anonymity of the data.

Patients

All consecutive hospitalized adult patients aged 18 years or older who underwent an incision and drainage procedure for a perianal abscess were retrospectively identified through the hospital's medical records system. Patients treated conservatively and those with incomplete clinical and follow-up data were excluded from the study. Further exclusion criteria included patients with inflammatory bowel disease (n=2), perianal abscesses associated with tumoral lesions (n=1), and Fournier's gangrene (n=10). Patients with recurrent perianal abscesses were included in the study. In total, 141 patients were included in the study (Figure 1).

Treatment and Procedure

The attending surgeon initiated perioperative empirical antibiotic treatment for all patients with β-lactam/β-lactamase inhibitors or fluoroquinolones, supplemented with metronidazole. Intraoperatively, bacteriological culture samples were obtained using either a swab stick or by aspirating pus from the abscess after incision at the area of most fluctuation.[9] The decision to perform microbiological testing was at the discretion of the attending surgeon. At our institution, there was no standardized protocol guiding the decision to obtain culture samples; this decision was based solely on the surgeon's clinical judgment. Bacterial cultures obtained from the perianal abscess cavity were cultured under aerobic conditions in the hospital's microbiology laboratory.

All patients were discharged 24-48 hours after the procedure, receiving oral antibiotics similar to those administered perioperatively. Antibiotic regimens could not be adjusted based on antibiogram results, as microbiology findings typically became available within 48-72 hours, after the patients who underwent microbiological testing had already been discharged from the hospital.[8]

Variables and Data Collection

Patient demographics, including age, sex, weight, height, comorbidities, history of perianal surgical interventions, and microbiological test results with antibiograms (if performed), were retrospectively collected from medical records. The body mass index was calculated by dividing the weight by the height squared (kg/m^2). The results of the microbiological testing were categorized as negative, contamination, or positive.

Follow-up

Follow-up data were collected using the patient's medical records or via a telephone call performed in July 2024. All patients were requested to attend regular monthly visits at the outpatient general surgery clinics for the first 6 months following surgery. The perianal abscess and/or perianal fistula outcomes were noted as cure, perianal drainage from the fistulous tracts without intervention, or surgical treatment of perianal fistula.

Statistical Analysis

The primary outcome of the study was the rate of microbiological testing, the main exposure of interest. The grouping was based on the presence of microbiological testing. The microbiological and antibiotic resistance profiles of perianal abscesses among patients with microbiological testing were the secondary outcomes.

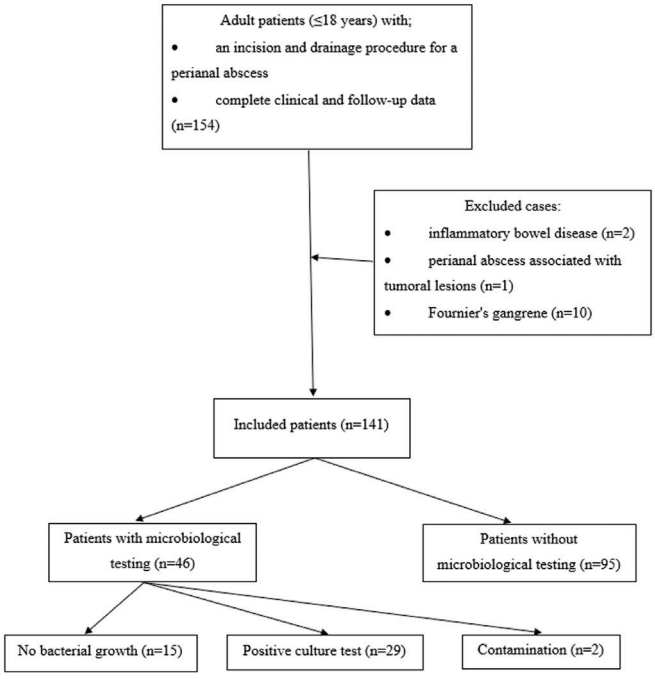

Figure 1. Flowchart of the study

For descriptive statistics, the mean ± standard deviation was used to present continuous data with a normal distribution. The median with minimum and maximum values was applied for continuous variables without a normal distribution. Numbers and percentages were used for categorical variables. The Shapiro-Wilk, Kolmogorov-Smirnov, and Anderson-Darling tests were used to analyze the normal distribution of the numerical variables.

To compare the differences in numerical variables between the two independent groups, the independent samples t-test was used for numerical variables that were determined to conform to the normal distribution. The Mann-Whitney U test was used for numerical variables determined not to conform to the normal distribution. The categorical variables were compared using Pearson's chi-square test or Fisher's exact test as appropriate.

Data were analyzed using SPSS Statistics for Windows (IBM Corp., IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA). The significance level (p-value) was determined at 0.05 in all statistical analyses.

Results

There were 141 patients, with a mean age of 40.8±13.0 years. Most patients were men (78.7%). Thirty-five patients (24.8%) had a history of perianal abscess and/or fistula, with 82.9% of these cases involving a prior perianal abscess. Additional clinical characteristics are summarized in Table 1.

Microbiological testing was performed on 46 patients (32.6%). Of these, 15 patients (32.6%) had no bacterial growth, whereas 29 patients (63.0%) had positive culture results. Polymicrobial infections were identified in three patients (6.5%). The most frequently detected bacterium was *E. coli*, found in 24 patients (52.2%), followed by *Klebsiella pneumoniae (K. pneumoniae)* in five patients (10.8%). The rates of the other bacteria are given in Table 2.

The comparison of patients with and without microbiological testing revealed no significant differences in demographic and clinical characteristics (p>0.05) (Table 3).

At a median follow-up of 93 days after discharge, 97 patients (68.8%) reported no complications or recurrence (Table 4). However, 15 patients (10.6%) experienced perianal drainage with varying intensity and frequency. Additionally, 29 patients (20.6%) required surgical intervention for a diagnosed perianal fistula.

The antibiotic resistance rates of *E. coli* and *K. pneumoniae* to standard antibiotics are shown in Table 5. The highest drug resistance for *E. coli* was detected with ampicillin (81.4%) and cefazolin (75.0%). Antibiotic resistance to *E. coli* was also observed with cefuroxime (61.1%), levofloxacin (60.0%), ceftazidime (59.1%), amoxicillin/clavulanate (55.6%), and ceftriaxone (55.6%). No drug resistance was observed with amikacin, colistin, meropenem, imipenem, or tigecycline for *E. coli*. The antibiotic susceptibility and resistance rates of *K. pneumoniae* are summarized in Table 5.

Table 1. Demographic and clinical characteristics of the patients (n=141)

Variable		Value
Age (years)†		40.8±13.0
Sex‡	Male	111 (78.7)
	Female	30 (21.3)
Body mass index (kg/m²)†		28.0±4.7
Comorbidities‡		54 (38.3)
Type of comorbidity‡		
	Hypertension	21 (14.9)
	Diabetes mellitus	22 (15.6)
	Coronary artery disease	6 (4.3)
	COPD	6 (4.3)
History of perianal abscess/ fistula‡		35 (24.8)
	Perianal abscess	29 (82.9)
	Perianal fistula	7 (17.1)
Previous perianal other surgeries‡		10 (7.1)

†: mean ± standard deviation, ‡: n (%)

COPD: Chronic obstructive pulmonary disease

Table 2. Details of the patients with microbiological analysis (n=46)

Variable		Value
Test results‡	No growth	15 (32.6)
	Contamination	2 (4.3)
	Positive	29 (63.0)
Polymicrobial abscess‡		3 (6.5)
Pathogenic bacteria‡,ζ	*E. coli*	24 (52.2)
	K. pneumoniae	5 (10.8)
	E. fecalis	1 (2.2)
	S. aureus	1 (2.2)
	N. gonorrhea	1 (2.2)

‡: n (%)

ζ: 32 isolated bacteria in 29 patients with positive test results

E. coli: Escherichia coli, K. pneumoniae: Klebsiella pneumoniae, E. fecalis: Enterococcus faecalis, S. aureus: Staphylococcus aureus, N. gonorrhea: Neisseria gonorrhoeae

Discussion

This retrospective study's findings revealed that microbiological testing was performed in nearly one-third of the patients undergoing surgical drainage for perianal abscesses. Positive cultures were obtained in 63% of the tested individuals, with *E. coli* and *K. pneumoniae* being the most frequently cultured bacteria. However, the high rates of antibiotic resistance observed in these organisms highlight the need for careful consideration when selecting appropriate antibiotic therapy.

The routine use of swab cultures in the management of perianal abscesses has been debated in previous studies, with sampling rates ranging from 41.8% to 78%.[2,6,8,9,11] Seow-En I and Ngu J.[11] suggested that such procedures may be unnecessary due to their minimal impact on patient management and outcomes. In their study, 78% of patients underwent microbiological testing, yet physicians did not review 96.5% of these results. Similarly, in a study involving 24 patients with perianal abscesses, only one-third of microbiological test results were reviewed by attending physicians.[8] Another study, including pediatric cases with pilonidal, gluteal, and perianal abscesses, reported that routine culture did not appear to alter treatment.[7] Additionally, several authors have reported no significant association between the presence of gut organisms and the development of fistulas or the recurrence of abscesses.[8,9] In line with these findings, the relatively low microbiological testing rate (32.6%) in our study likely reflects individual physician discretion rather than adherence to a standardized protocol or institutional guidelines. Swab cultures were not routinely recommended as part of clinical practice during the study period. Many clinicians may have chosen not to obtain cultures in the absence of systemic signs of infection or recurrent disease. Resource considerations may also have contributed, particularly when microbiological results were unlikely to impact clinical decision-making. Although we did not analyze the rate of review or subsequent treatment modifications based on test results, prospective studies could better elucidate the potential benefits of microbiological sampling in these patients.

Earlier research has demonstrated that *E. coli* is the predominant pathogen in perianal abscesses across various age groups and diagnostic techniques.[1-3,12,13] Zhu and Xu[14] found that *K. pneumoniae* was the predominant pathogen in infants under 3 months of age with perianal abscesses. Nevertheless, Liu et al.[5] found that *E. coli* was detected in 65% of 183 patients with perianal abscesses. They also categorized the study group based on the presence of diabetes mellitus. *Klebsiella pneumoniae* was more frequent than *E. coli* among people with

Table 3. Demographic and clinical characteristics of the patients with and without microbiological testing

Variable		Patients		
		With microbiological testing (n=46)	Without microbiological testing (n=95)	p
Age (years)†		39.3±10.3	41.5±14.2	0.294
Sex‡	Male	38 (82.6)	73 (76.8)	0.514
	Female	8 (17.7)	22 (23.2)	
Body mass index (kg/m^2)†		27.4±5.3	27.1±4.4	0.689
Comorbidities‡		15 (32.6)	39 (41.1)	0.361
Type of comorbidity‡				
	Hypertension	4 (8.7)	17 (17.9)	0.208
	Diabetes mellitus	6 (13.0)	16 (16.8)	0.629
	Coronary artery disease	2 (4.3)	4 (4.2)	1.0
	COPD	1 (2.2)	5 (5.3)	0.664
History of perianal abscess/fistula‡		14 (30.4)	21 (22.1)	0.304
	Perianal abscess	13 (92.9)	16 (76.2)	0.125
	Perianal fistula	1 (2.2)	5 (23.8)	0.427
Previous perianal other surgeries‡		1 (2.2)	9 (9.5)	0.166
Multiple abscesses‡		13 (28.3)	14 (14.7)	0.069

†: mean ± standard deviation, ‡: n (%)

COPD: Chronic obstructive pulmonary disease

Table 4. Outcome of the patients in the study group (n=141)

Variable		Value	
Follow-up (days)§		93 (3-2347)	
Outcome‡	No sequelae	97 (68.8)	
	Recurrences	44 (31.2)	
	Symptoms for perianal fistula		15 (34.1)
	Surgery for perianal fistula		29 (65.9)

§: median (min-max), ‡: n (%)

diabetes, contrary to the findings obtained by Alabbad et al.[6], in which *E. coli* was the most common pathogen in patients with and without diabetes mellitus. Others used the term "gut organisms" without reporting the names or incidences of the specific pathogens.[9] In line with previous findings, *E. coli* was the most frequently isolated pathogen in our study, followed by *K. pneumoniae*. Nevertheless, the relatively small number of cultured pathogens may limit the comprehensiveness of our bacteriological findings.

Antibiotic sensitivity results for bacteria isolated from perianal abscesses have varied across studies. In the study by Liu et al.[5], *E. coli* isolates were susceptible to first-generation cephalosporins, with rates of 84.6% in patients with diabetes and 65.1% in patients without diabetes. Similar findings have been reported by Seow-En and Ngu[11], who found that 98% of isolated organisms were sensitive to routine empirical antibiotics, such as amoxicillin/clavulanic acid and metronidazole. Contrary to these findings, Bender et al.[2] reported that acquired drug resistance to common antibiotics for *E. coli*, *S. aureus,* and *Bacteroides* and *Streptococcus* species was frequently seen in patients with perianal abscesses. Due to the varying drug resistance rates in children with perianal abscesses, Guner Ozenen et al.[3] found the highest antimicrobial coverage rate with ertapenem plus a glycopeptide, followed by ertapenem plus clindamycin. In the current study, we observed conflicting findings: *E. coli* and *K. pneumoniae* were

Table 5. Antibiotic resistance rates of *E. coli* and *K. pneumoniae* in the bacterial culture of perianal abscess

Antibiotic	*E. coli**	*K. pneumoniae**
Amikacin	20/0 (0)	3/0 (0)
Amoxicillin/clavulanic acid	18/10 (55.6)	2/1 (50)
Ampicillin	17/14 (82.4)	2/2 (100)
Ertapenem	16/1 (6.3)	3/0 (0)
Gentamycin	19/3 (15.8)	1/0 (0)
Colistine	13/0 (0)	3/0 (0)
Meropenem	12/0 (0)	4/0 (0)
Imipenem	9/0 (0)	--
Piperacillin/tazobactam	21/1 (4.8)	5/2 (40.0)
Cefazolin	12/9 (75.0)	1/1 (100)
Cefoxitin	17/4 (25.5)	3/0 (0)
Cefuroxime	18/11 (61.1)	3/1 (33.3)
Ceftazidime	22/13 (59.1)	4/1 (25.0)
Ceftriaxone	18/10 (55.6)	3/1 (33.3)
Cefepim	19/9 (47.4)	4/1 (25.0)
Ciprofloxacin	22/8 (36.4)	3/1 (33.3)
Levofloxacin	5/3 (60.0)	--
Tigecycline	20/0 (0)	3/0 (0)
Trimethoprim/sulfamethoxazole	22/7 (31.8)	4/0 (0)
Aztreonam	7/2 (28.6)	2/0 (0)

*: Number of isolates tested/number of resistant isolates (%), *E. coli: Escherichia coli, K. pneumoniae: Klebsiella pneumoniae*

more likely to be resistant to cephalosporins and amoxicillin/clavulanic acid. These findings suggest that standard empiric antibiotics may be insufficient for treating perianal abscesses, given the relatively high resistance rates observed among the isolated pathogens. Although routine post-drainage antibiotic use has been debated in various studies[10,15,16], we, along with others, advocate for routine microbiological testing and treatment adjustments based on culture results, especially in cases with complex or severe local disease.[2]

The high antibiotic resistance rates observed in our study, particularly the 81.4% resistance to ampicillin and 75.0% resistance to cefazolin among *E. coli* isolates, raise important questions about current empiric therapy protocols. Traditional first-line empiric regimens, consisting of β-lactam/β-lactamase inhibitors or fluoroquinolones with metronidazole, may be inadequate in settings with high resistance rates, as reported in other studies.[2] Our findings revealed high resistance rates of *E. coli* and *K. pneumoniae* to commonly used empiric antibiotics such as ampicillin, amoxicillin/clavulanate, and several cephalosporins. These resistance patterns suggest that such antibiotics may not be appropriate for empirical use in patients with perianal abscesses in our setting. In contrast, carbapenems, tigecycline, amikacin, and colistin showed excellent in vitro activity against the isolated strains, though their use should be reserved for selected cases due to concerns about broad-spectrum overuse.

Although our data are limited to aerobic cultures from a single center and do not constitute a formal institutional antibiogram, they may still serve as a valuable reference for empirical antibiotic selection in similar clinical contexts. These findings support the integration of local microbiological surveillance into antibiotic stewardship initiatives to guide empiric therapy and reduce inappropriate use of broad-spectrum agents. Accordingly, institutions should consider revising their

empiric antibiotic protocols based on local resistance patterns and established antimicrobial stewardship principles.

Given the observed resistance patterns, several therapeutic strategies warrant consideration in high-resistance settings. First, empiric therapy could be escalated to include broader-spectrum agents such as piperacillin/tazobactam, which demonstrated only 4.8% resistance among *E. coli* isolates in our study. Second, the universal sensitivity to carbapenems, amikacin, and colistin suggests these agents could be reserved for severe cases or those with known risk factors for multidrug-resistant organisms. However, the routine use of such broad-spectrum antibiotics must be balanced against the risk of further promoting antimicrobial resistance and increased healthcare costs.

Study Limitations

This study has several limitations. Although the cohort represented a convenience sample of all eligible patients over 7 years, and no power calculation was performed as the study was exploratory and descriptive in nature, our findings may not be fully generalizable due to the single-center retrospective design and the limited number of patients undergoing microbiological testing. The retrospective design also limited our ability to gather reliable data on preoperative and postoperative antibiotic use, patient compliance, adverse effects, and long-term outcomes. The absence of a standardized protocol for culture sampling introduces selection bias, as the decision was based on individual surgeon preference rather than objective criteria. Furthermore, our microbiological testing was limited to aerobic culture conditions, which may have resulted in an underrepresentation of anaerobic pathogens commonly associated with perianal abscesses. Additionally, the delayed availability of culture results in routine clinical settings may have further limited their utility in guiding immediate treatment decisions. Importantly, there was no predefined protocol to modify or tailor antibiotic therapy based on culture findings, which restricted the potential clinical impact of microbiological testing. This methodological limitation is consistent with routine clinical practices in many institutions but should be addressed in future studies using more comprehensive culture techniques or molecular diagnostics. Moreover, although we observed significant resistance patterns in some isolated pathogens, our study design does not allow us to establish a causal relationship between specific microbiological findings and clinical outcomes, such as treatment failure or fistula formation. The inability to evaluate the relationship between antibiotic resistance and clinical outcomes, such as recurrence or fistula formation, represents another limitation of this study. This was primarily due to the heterogeneity of bacterial isolates and the lack of standardized microbiological testing throughout the 7-year study period. Additionally, the follow-up period in our study was limited to a median of 93 days, which may not be sufficient to evaluate longer-term outcomes, such as delayed fistula recurrence, chronic symptoms, or antibiotic-related complications. Future studies should incorporate standardized long-term follow-up to assess these outcomes more accurately.

Future prospective multicenter studies using anaerobic or metagenomic approaches are needed to better evaluate the role of microbiological testing and the impact of tailored antibiotic therapy on clinical outcomes in patients with perianal abscesses. These studies should also consider the cost-effectiveness and potential benefits of culture-guided therapy, especially in patients at a higher risk of complications.

The generalizability of our findings may be limited due to the single-center, retrospective nature of the study and the specific patient population treated at our institution. Our cohort primarily consisted of adult patients managed at a tertiary care hospital, which may not fully represent patients treated in community settings or other healthcare systems with different empirical antibiotic protocols. Additionally, microbiological testing was not performed systematically, and anaerobic cultures were not included, potentially leading to an incomplete representation of the microbial spectrum encountered in perianal abscesses. Regional differences in antibiotic resistance patterns may also limit the external applicability of our results, as resistance profiles are known to vary substantially between geographic areas and healthcare institutions. Therefore, although our findings provide valuable insight into local resistance trends and the utility of microbiological testing, they should be interpreted with caution when applied to other settings, and multicenter studies are warranted to validate these observations.

Conclusion

In conclusion, *E. coli* and *K. pneumoniae* were the most frequently identified pathogens in patients undergoing surgical drainage for perianal abscesses. Although microbiological testing was performed in nearly one-third of the patients, significant antibiotic resistance rates were observed in these bacteria, particularly to commonly used empiric antibiotics such as cephalosporins and amoxicillin/clavulanic acid. These findings highlight the presence of antibiotic-resistant organisms in perianal abscesses. However, given that microbiological results did not routinely inform treatment decisions in our study, the potential clinical benefit of culture-guided therapy remains uncertain. Future research is needed to determine whether tailoring antibiotics based on culture results improves outcomes in high-risk patient groups.

Ethics

Ethics Committee Approval: The local Ethics Committee of University of Health Sciences Hamidiye Scientific Research

Ethics Committee approved the study (approval number: 2/26, dated: 16.02.2024) which adhered to the principles outlined in the Declaration of Helsinki.

Informed Consent: Written informed consent was waived due to the study's retrospective design and the anonymity of the data.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.E.B., Y.K.K., Z.Ş., Concept: S.B., Z.Ş., Design: S.E.B., Data Collection or Processing: S.E.B., Y.K.K., Analysis or Interpretation: A.H., Literature Search: S.B., Y.K.K., Z.Ş.,Writing: S.E.B.

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REFERENCES

1. Hong JC, Chen JS, Jiang ZJ, Chen ZC, Ruan N, Yao XP. Microbiota in adult perianal abscess revealed by metagenomic next-generation sequencing. Microbiol Spectr. 2024;12:e0347423.
2. Bender F, Eckerth L, Fritzenwanker M, Liese J, Askevold I, Imirzalioglu C, Padberg W, Hecker A, Reichert M. Drug resistant bacteria in perianal abscesses are frequent and relevant. Sci Rep. 2022;12:14866.
3. Guner Ozenen G, Akaslan Kara A, Ozer A, Kacar P, Ergun D, Aydin A, Genisol Ataman I, Polatdemir K, Payza AD, Sorguc Y, Oral A, Bayram N, Devrim I. Perianal abscess in children: an evaluation of microbiological etiology and the effectiveness of antibiotics. Pediatr Surg Int. 2023;39:272.
4. Gosselink MP, van Onkelen RS, Schouten WR. The cryptoglandular theory revisited. Colorectal Dis. 2015;17:1041-1043.
5. Liu CK, Liu CP, Leung CH, Sun FJ. Clinical and microbiological analysis of adult perianal abscess. J Microbiol Immunol Infect. 2011;44:204-208.
6. Alabbad J, Abdul Raheem F, Alkhalifa F, Hassan Y, Al-Banoun A, Alfouzan W. Retrospective clinical and microbiologic analysis of patients with anorectal abscess. Surg Infect (Larchmt). 2019;20:31-34.
7. Shaughnessy MP, Park CJ, Zhang L, Cowles RA. The limited utility of routine culture in pediatric pilonidal, gluteal, and perianal abscesses. J Surg Res. 2019;239:208-215.
8. Lalou L, Archer L, Lim P, Kretzmer L, Elhassan AM, Awodiya A, Seretis C. Auditing the routine microbiological examination of pus swabs from uncomplicated perianal abscesses: clinical necessity or old habit? Gastroenterology Res. 2020;13:114-116.
9. Xu RW, Tan KK, Chong CS. Bacteriological study in perianal abscess is not useful and not cost-effective. ANZ J Surg. 2016;8:782-784.
10. Nasasra A, Hershkovitz Y, Ashkenazi I, Hammerschlag J, Zmora O, Jeroukhimov I. Antibiotic treatment has no influence on anal fistula formation and recurrent perianal abscess after incision and drainage of cryptogenic perianal abscess: a randomized single-blinded prospective study. Dis Colon Rectum. 2024;67:1072-1076.
11. Seow-En I, Ngu J. Routine operative swab cultures and post-operative antibiotic use for uncomplicated perianal abscesses are unnecessary. ANZ J Surg. 2017;87:356-359.
12. Paran M, Dagan J, Hameiri G, Dudkiewicz M, Kessel B. Does microbiology of perianal abscesses affect the length of hospital stay? Am J Med Sci. 2024;368:320-324.
13. Ulug M, Gedik E, Girgin S, Celen MK, Ayaz C. The evaluation of bacteriology in perianal abscesses of 81 adult patients. Braz J Infect Dis. 2010;14:225-229.
14. Zhu Y, Xu F. The pathogens and curative effects analysis of perianal abscess of infants under 3 months. Turk J Pediatr. 2019;61:40-43.
15. Ghahramani L, Minaie MR, Arasteh P, Hosseini SV, Izadpanah A, Bananzadeh AM, Ahmadbeigi M, Hooshanginejad Z. Antibiotic therapy for prevention of fistula in-ano after incision and drainage of simple perianal abscess: a randomized single blind clinical trial. Surgery. 2017;162:1017-1025.
16. Sözener U, Gedik E, Kessaf Aslar A, Ergun H, Halil Elhan A, Memikoğlu O, Bulent Erkek A, Ayhan Kuzu M. Does adjuvant antibiotic treatment after drainage of anorectal abscess prevent development of anal fistulas? A randomized, placebo-controlled, double-blind, multicenter study. Dis Colon Rectum. 2011;54:923-929.

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RESEARCH ARTICLE

Lactate Dehydrogenase in Patients with Metastatic Colorectal Cancer: Retrospective Study to Explore a Target Subgroup for Utilization as a Tumor Marker

Erman Akkuş[1,2], Beliz Bahar Karaoğlan[1,2], Utkucan Turmuş[3], Güngör Utkan[1,2]

[1]Ankara University Faculty of Medicine, Department of Medical Oncology, Ankara, Türkiye
[2]Ankara University Cancer Research Institute, Ankara, Türkiye
[3]Ankara University Faculty of Medicine, Department of Internal Medicine, Ankara, Türkiye

ABSTRACT

Aim: Serum lactate dehydrogenase (LDH) may be a prognostic marker in metastatic colorectal cancer (mCRC). However, mCRC is a heterogeneous disease, and data on LDH-related subgroups are limited. This study aimed to investigate clinical and molecular features associated with LDH in mCRC.

Method: Demographic, clinical, treatment response, and survival data from a retrospective cohort of patients diagnosed with synchronous mCRC between 2019 and 2023 were analyzed according to serum LDH levels. Lactate dehydrogenase A (LDHA) gene expression and molecular features were assessed in an independent cohort.

Results: The clinical cohort included 135 patients. The median LDH level was 231 U/L (range: 106-5,655), and 55.1% (n=75) of patients had high LDH. The presence of liver metastases (p=0.037), the number of liver metastases (≥5 vs. <5, p=0.035), carcinoembryonic antigen (p=0.000), carbohydrate antigen 19-9 (p=0.042), and C-reactive protein (p=0.002) levels were significantly associated with high LDH. Among patients with liver-only metastases, high LDH was significantly associated with worse overall survival (OS) (19.7 months [95% confidence interval (CI): 13.8-28.1] vs. 39.0 months (95% CI: 19.8-59.2), p=0.017). Non-responders to 5-fluorouracil, leucovorin, and oxaliplatin had higher LDH levels (p=0.016) and worse OS [11.4 months (95% CI: 6.2-12.7) vs. not reached, p=0.002]. Among 84 patients in the independent mCRC cohort, 16.7% (n=14) had high LDHA expression in tumor tissue. High LDHA expression was associated with lower microsatellite instability scores (p=0.048) and higher hypoxia scores (p for Buffa=0.001, Winter=0.003), but not with tumor mutational burden or aneuploidy score. Expression of metabolic–epithelial–mesenchymal transition pathway genes was correlated with LDHA expression.

Conclusion: LDH may be a potential marker in microsatellite-stable (MSS), nonimmunogenic, liver-dominant mCRC. Whether LDH could serve as a biomarker for immunotherapy studies in MSS colorectal cancer warrants investigation in future studies.

Keywords: Lactate dehydrogenase, metastatic colorectal cancer, liver metastasis, tumor marker, microsatellite stability, microsatellite stable, hypoxia

Introduction

Colorectal cancer (CRC) ranks as the third leading cause of cancer-related deaths globally, with more than 1.85 million new cases and 850,000 deaths each year. Approximately 20% of patients present with synchronous metastatic disease at diagnosis. Despite advances in management, the 3-year survival rate of metastatic colorectal cancer (mCRC) is nearly 30%.[1]

Well-established predictive and prognostic biomarkers, such as rat sarcoma (RAS) and B-Raf proto-oncogene (BRAF) mutations and microsatellite instability (MSI), are already incorporated into routine clinical practice for the treatment of mCRC.[2] However, mCRC is a clinically and molecularly heterogeneous disease, and novel treatment options, such as immunotherapy, are under investigation.[2] Therefore, there is a need for additional biomarkers and for further characterization

Address for Correspondence: Güngör Utkan MD, Ankara University Faculty of Medicine, Department of Medical Oncology, Ankara, Türkiye; Ankara University Cancer Research Institute, Ankara, Türkiye
E-mail: gungorutkan_md@yahoo.com **ORCID ID:** orcid.org/0000-0001-8445-6993
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of existing biomarkers according to disease presentation, clinical setting, patient subgroups, disease biology, and molecular subtypes.[3]

Most cancer cells rely on aerobic glycolysis, also known as the Warburg effect, to sustain growth even in the presence of oxygen, resulting in increased lactate production and secretion. Lactate dehydrogenase (LDH) plays a pivotal role in glucose metabolism by regulating the interconversion of pyruvate and lactate. The lactate dehydrogenase A (LDHA) subunit catalyzes the conversion of pyruvate to lactate.[4] Serum LDH levels have been reported to have predictive and prognostic value in mCRC, and serum LDH has also been considered an indirect marker of hypoxia and angiogenesis.[5] However, LDH-related clinical and molecular characteristics in mCRC remain poorly defined. Characterization of these features is required to implement LDH as a biomarker in mCRC, a highly heterogeneous disease. The objective of this study is to investigate circulating serum LDH levels and tumor LDHA gene expression in mCRC to define a framework for its potential use as a tumor marker, based on the hypothesis that LDH is associated with specific clinical and molecular features.

Materials and Methods

Patients and Clinical Assessments

Retrospective cohort data from patients newly diagnosed with mCRC between 2019 and 2023 were analyzed. Patients of any gender aged ≥18 years who were newly diagnosed with synchronous (*de novo*) mCRC, with resectable, potentially resectable, or unresectable disease, were included. Patients who developed metastatic disease following recurrence of localized disease (that is, not de novo metastatic disease) and patients without LDH data were excluded.

Age, gender, comorbidities (diabetes, hypertension, or coronary artery disease), smoking history, primary tumor location, metastatic sites (liver, peritoneum, lung, or bone), number of liver metastases, serum LDH, plasma carcinoembryonic antigen (CEA), carbohydrate antigen 19-9 (CA19-9), C-reactive protein (CRP) levels, neutrophil-to-lymphocyte ratio, serum uric acid levels at diagnosis, presence of urgent surgery, MSI, RAS and BRAF mutational status, systemic and local treatments and treatment response, disease progression, and survival data were recorded. Patients were divided into two groups, high LDH and normal LDH, according to serum LDH levels at diagnosis (LDH greater than the upper limit of normal (ULN) of 214 U/L and LDH less than or equal to the ULN). Demographic and clinical parameters were compared between the high and normal LDH groups.

Response to first-line treatment was evaluated according to Response Evaluation Criteria in Solid Tumors version 1.1. Progression-free survival (PFS) was defined as the time from initiation of treatment to first documented disease progression or death. Overall survival (OS) was defined as the time from initiation of treatment to death or the patient's last hospital visit.

Ethical approval was obtained from the Clinical Research Ethics Committee of Ankara University Faculty of Medicine (decision no.: İ11-694-22, date: 10.01.2023) in compliance with the Declaration of Helsinki. The study analyzed retrospective, anonymized clinical data. Therefore, informed consent was not required, and the ethics committee granted a waiver for this purpose.

Molecular Assessments

Data from The Cancer Genome Atlas (TCGA) Program PanCancer Atlas for colorectal adenocarcinoma were utilized, and cBioPortal was used for metadata collection and analyses.[6] Only patients with metastatic disease within TCGA cohort were included. Messenger RNA expression z scores of the LDHA gene in tumor samples relative to normal samples [log RNA sequencing version 2 RSEM (z score threshold ±2] were analyzed. Patients were divided into two groups, LDHA high expression and LDHA normal expression, according to the z score (LDHA high >2 and LDHA normal ≤2).

MSI Microsatellite Analysis for Normal-Tumor InStability scores[7], Buffa and Winter hypoxia scores[8,9], tumor mutational burden (TMB), and aneuploidy scores[10] were compared between the LDHA high and LDHA normal expression groups. Genes whose expression correlated with LDHA expression and showed the highest correlation coefficients were identified. The correlation between LDHA expression and gene sets corresponding to consensus molecular subtype (CMS) 3 (metabolic) was analyzed.[11] In addition, the correlation between LDHA expression and the expression of epithelial–mesenchymal transition genes, representing CMS4 (mesenchymal), was evaluated.[11] Gene sets for metabolic pathways were obtained from the Kyoto Encyclopedia of Genes and Genomes as referenced in the original study.[11,12] The gene set for epithelial-mesenchymal transition was obtained from Gene Set Enrichment Analysis.[13,14]

Statistical Analyses

Continuous variables were reported as median (minimum-maximum), and categorical variables were presented as percentages. Missing data were reported in the tables and included in the statistical analyses. Univariable comparisons were performed using the chi-square test, Fisher's exact test, Student's t-test, the Mann-Whitney U test, and Cox regression, as appropriate. All p-values were based on two-

tailed tests of significance, with a significance threshold of p=0.05. All statistical analyses were conducted using MedCalc® Statistical Software version 22.026 (MedCalc Software Ltd, Ostend, Belgium). Calculated metadata from cBioPortal were used where applicable.[6]

Results

Serum LDH Levels and Clinical Characteristics

A total of 135 patients with synchronous mCRC were included (Figure 1). The demographic and clinical characteristics of the overall study population and the LDH subgroups are presented in Table 1. The median age was 60 years (range: 30-80), and 61.5% (n=83) of patients were men. The primary tumor location was rectal in 44.5% (n=60) of patients. Liver metastases were present in 88.1% (n=119) of patients. RAS mutations were detected in 42.2% (n=57). The median serum LDH level was 231 U/L (range: 106–5,655), and 55.1% (n=75) of patients had LDH levels above the ULN. Among these patients, 16.0% (n=12) had LDH levels exceeding 1,000 U/L. Liver metastases were significantly more frequent in the high-LDH group than in the normal-LDH group (93.3% vs. 81.6%, p=0.037). When the number of liver metastases was categorized as ≥5 versus <5, the proportion of patients with ≥5 liver metastases was significantly elevated in the high-LDH group (69.3% vs. 43.3%, p=0.035). Median CEA levels [134 (0.93-17,796)] vs. 14.7 [0.94–949] ng/mL, p=0.00), median CA19-9 levels [149.80 (0.80-12,443) vs. 80.75 (0.80-19,300)] U/mL, p=0.042), and median CRP levels [19.75 (0.30-239.60) vs. 9.00 (0.80-163.10) mg/L, p=0.002] were significantly elevated in the high-LDH group. When LDH was analyzed as a continuous variable, the strength of the associations increased, with improved significance levels (p<0.001 for the presence of liver metastases, p=0.002 for the number of liver metastases, p=0.017 for CEA, and p<0.001 for CRP). These findings indicate that serum LDH is associated with both the presence and burden of liver metastases in synchronous mCRC.

Serum LDH Levels and Survival

As serum LDH was found to be associated with liver metastases, survival outcomes were evaluated in patients with liver-only mCRC. PFS did not differ between the high-LDH and normal-LDH groups (11.2 months (95% CI: 6.9-14.2) vs. 11.4 months [(95% CI: 7.0-13.7), p=0.276)] (Figure 2a). In contrast, high LDH was significantly associated with worse OS [19.7 months (95% CI: 13.8-28.1) vs. 39.0 months [95% CI: 19.8-59.2), p=0.017] (Figure 2b).

Treatment and response characteristics according to LDH groups are presented in Table 2. Despite differences in the

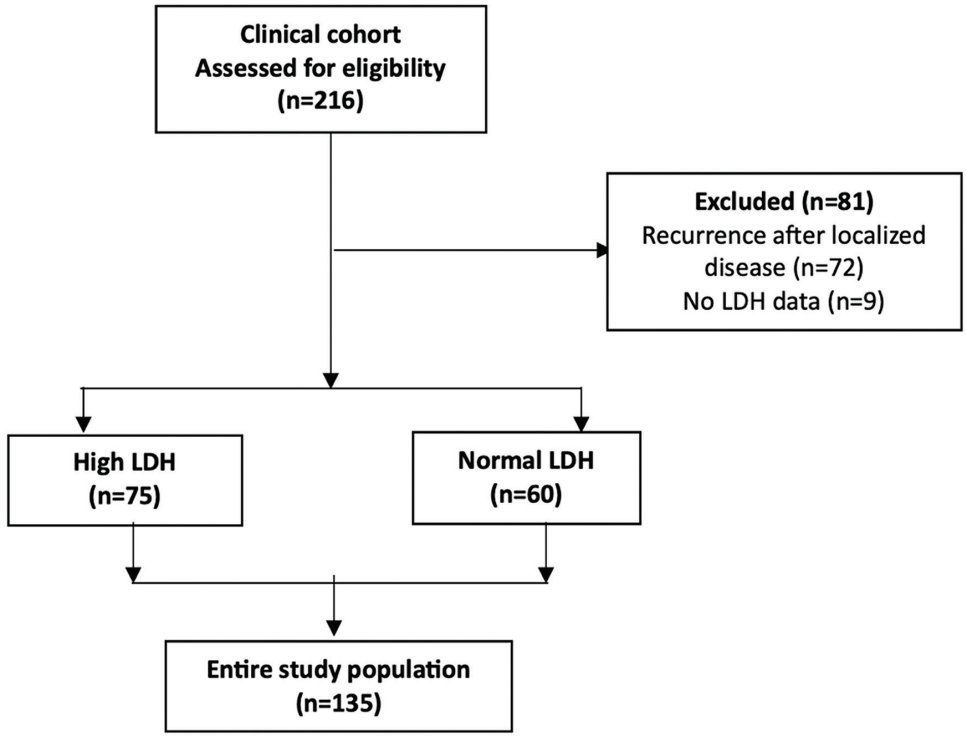

Figure 1. Patient flow diagram of the study
LDH: Lactate dehydrogenase

presence and burden of liver metastases, first-line systemic treatments, local treatments, and best response rates did not differ between the LDH groups. Patients with liver-only metastatic disease who received first-line 5-fluorouracil (5-FU), leucovorin, and oxaliplatin chemotherapy were further evaluated for treatment response in relation to serum LDH levels. Non-responders (stable disease or progressive disease) had a median LDH level of 250 U/L (range: 167-1,898), which was significantly higher than that observed in responders (complete or partial response) [median LDH

Table 1. Characteristics of the patients and LDH groups

	Study population (n=135)	**LDH>ULN (n=75, 55.5%)**	**LDH<ULN (n=60, 44.5%)**	**p**
Age, median (min-max)	60 (30-80)	59 (30-76)	60 (31-80)	0.447
Gender, n (%)				
Male	83 (61.5)	45 (60)	38 (63.3)	
Female	52 (38.5)	30 (40)	22 (36.7)	0.692
Comorbidities, n (%)				
Diabetes	25 (18.5)	5 (6.6)	10 (16.7)	0.620
Hypertension	43 (31.9)	20 (26.6)	23 (38.3)	0.148
Coronary disease	13 (9.7)	5 (6.6)	8 (13.3)	0.192
Hypothyroidism	9 (6.6)	6 (8)	3 (5)	0.487
Smoking history, n (%)	70 (51.9)	41 (54.7)	29 (48.3)	0.464
Primary site, n (%)				
Colon	75 (55.5)	46 (61.3)	29 (48.3)	0.307
Rectum	60 (44.5)	32 (38.7)	28 (51.7)	
Metastatic site, n (%)				
Liver	119 (88.1)	70 (93.3)	49 (81.6)	**0.037**
Lung	35 (25.9)	17 (22.7)	18 (30)	0.334
Bone	6 (4.4)	4 (5.3)	2 (3.3)	0.693
Peritoneal	18 (13.3)	11 (14.7)	7 (11.6)	0.610
Number of liver metastasis, n (%)				
≥5	78 (57.7)	52 (69.3)	26 (43.3)	**0.035**
<5	35 (25.9)	16 (21.3)	19 (31.6)	
MSI-H, n (%)	3 (2.2)	2 (1.4)	1 (<1)	-
RAS mutant, n (%)	57 (42.2)	31(41.3)	26 (43.3)	0.482
RAF mutant, n (%)	1 (<1)	1 (<1)	0	-
ABO group, n (%)				
AB	9 (6.5)	7 (9.7)	4 (5.9)	
A	60 (44.9)	38 (50)	26 (44)	
B	19 (14.1)	7 (9.7)	9 (14.9)	0.393
O	42 (31)	21 (27.4)	19 (31.6)	
UK	5 (3.5)	2 (3.2)	2 (3.6)	
CEA, ng/mL, median (min-max)	38.75 (0.93-17,796)	134 (0.93-17,796)	14.7 (0.94-949)	**<0.001**
Ca19-9, U/mL, median (min-max)	93.50 (0.80-19,300)	149.80 (0.80-12,443)	80.75 (0.80-19,300)	**0.042**
CRP, mg/L, median (min-max)	14.15 (0.30-239.60)	19.75 (0.30-239.60)	9 (0.80-163.10)	**0.002**
NLR, median (min-max)	3.14 (1-12.56)	3.28 (1.13-12.56)	2.95 (1-8.57)	0.109
Albumin, g/dL, median (min-max)	3.99 (2.52-4.91)	3.96 (2.52-4.85)	4.09 (2.98-4.91)	0.142
Uric acid, mg/dL median (min-max)	5 (2-9.5)	5 (2.2-9.5)	4.95 (2-7.4)	0.746

LDH: Lactate dehydrogenase, ULN: Upper limit of normal, CEA: Carcinoembryonic antigen, Ca19-9: Carbohydrate antigen 19-9, CRP: C-reactive protein, NLR: Neutrophile/lymphocyte ratio, RAS: Rat sarcoma, MSI-H: Microsatellite instability-high

198 U/L (range: 137-1,554), p=0.016] (Figure 3a). Among these patients, high LDH was significantly associated with worse OS [11.4 months (95% CI: 6.2-12.7)] vs. not reached, p=0.002) (Figure 3b).

Tumor LDHA Expression and Molecular Characteristics

Among 594 patients with colorectal adenocarcinoma in TCGA cohort, 14.1% (n=84) had metastatic disease. Of these, 16.7% (n=14) exhibited high LDHA expression in tumor tissue.

MSI MANTIS scores, Winter and Buffa hypoxia scores, TMB, and aneuploidy scores were compared between LDHA high-expression and LDHA normal-expression groups among patients with available data (Figure 4). The median MSI MANTIS score was significantly lower in the LDHA high-expression group [2,817 (33-3,807) vs. 3,325 (66-8,168), p=0.048]. Median Winter and Buffa hypoxia scores were significantly increased in the LDHA high-expression group [Winter: 32 (14-52) vs. 15 (-20-32), p=0.003; Buffa: 35 (13-39) vs. 17 (-17-29), p=0.001]. Median TMB was

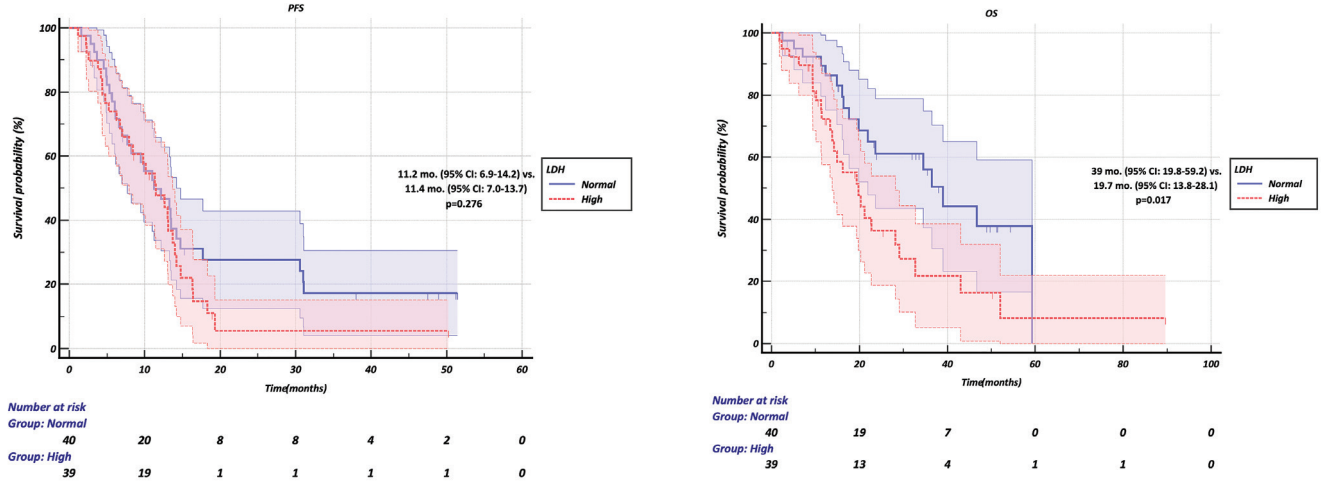

Figure 2. (a) Progression-free survival (PFS) and (b) overall survival (OS) among patients with liver-only metastatic colorectal cancer according to serum LDH levels.
LDH: Lactate dehydrogenase, CI: Confidence interval

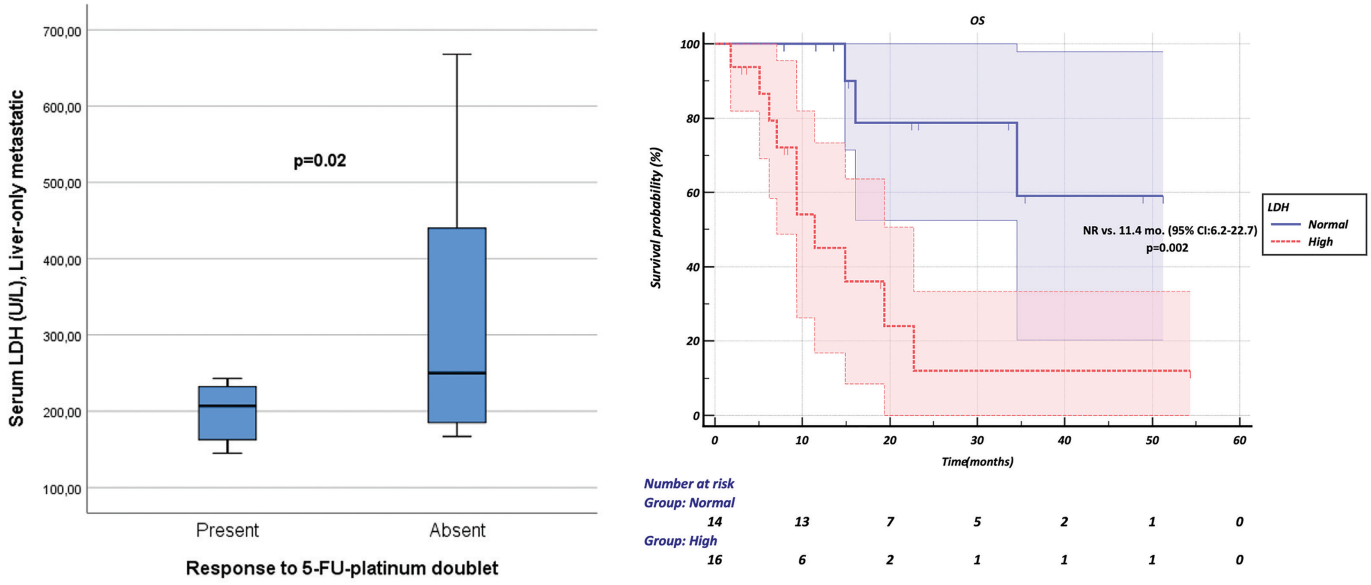

Figure 3. (a) Comparison of serum LDH levels between responders and non-responders to first-line FOLFOX chemotherapy among patients with liver-only metastatic colorectal cancer and (b) overall survival (OS) according to LDH level in this patient group.
LDH: Lactate dehydrogenase, CI: Confidence interval

3.13 mutations/Mb (range: 1.73-5.83) in the LDHA high-expression group and 3.01 mutations/Mb (range: 0.00-7.67) in the LDHA normal-expression group (p=0.320). Median aneuploidy scores did not differ between groups [14.5 (4-25) vs. 16 (2-29), p=0.270]. These findings suggest that LDH is associated with hypoxia and metabolic pathways in CRC cells rather than with genomic instability or immunogenicity.

Gene expression correlation analyses further supported a role for LDHA in nonimmunogenic, metabolic, and epithelial–mesenchymal transition pathways in mCRC. Genes most strongly correlated with LDHA expression included phosphoglycerate kinase 1, PSMA1, ELP4, SAAL1, RRM1, ADM, AKIP1, COQ2, MTCH2, SAP30, MELK, ALDOA, and ANKRD37 (Table S1). Phosphoglycerate kinase 1, a key enzyme in the glycolytic pathway, showed the strongest correlation with LDHA expression (Spearman's rho=0.58, p<0.001, q<0.001). Among the gene sets related to metabolic pathways (14 pathways in total), the glucose–pentose pathway showed the strongest association with LDHA expression, which was significantly positively correlated with 48.1% (17 of 23) of genes within the glucose–pentose pathway. Within the epithelial-mesenchymal transition gene set, LDHA expression was significantly correlated with CD44 (p<0.001, q=0.007, a cell-surface glycoprotein involved in cell adhesion and migration), CD59 (p<0.001, q=0.021, a cell-surface glycoprotein), *PLOD2* (p=0.001, q=0.052, a catalyst of the hydroxylation of lysyl residues in collagen-like peptides), *SAT1* (p<0.001, q=0.017, an acetyltransferase involved in polyamine metabolism), and *TPM4* (p<0.001, q=0.033, a member of the tropomyosin family).

Discussion

This study explored LDH-associated clinical and molecular features to define specific patient subgroups in mCRC to facilitate further investigation and support the use of LDH as a tumor marker. Serum LDH was associated with both

Table 2. Treatment characteristics of patients and LDH groups

	Study population (n=135)	LDH>ULN (n=75, 55.5%)	LDH<ULN (n=60, 44.5%)	p
First-line treatment, n (%)				
5-FU-OX doublet	72 (52.9)	32 (42.7)	40 (66.7)	
5-FU-OX doublet + bevacizumab	31 (22.8)	18 (24)	13 (21.7)	
5-FU-OX doublet + anti-EGFR	23 (16.9)	16 (21.3)	7 (11.6)	
Only 5-FU	1 (0.7)	1 (1.3)	0 (0)	
5-FU-IRI doublet	1 (0.7)	1 (1.3)	0 (0)	
5-FU-IRI doublet + bevacizumab	1 (0.7)	1 (1.3)	0 (0)	0.138
5-FU-IRI doublet + anti-EGFR	2 (1.5)	2 (2.7)	0 (0)	
Triplet	1 (0.7)	1 (1.3)	0 (0)	
Triplet + bevacizumab	3 (2.2)	2 (2.7)	0 (0)	
Triplet + anti-EGFR	1 (0.7)	1 (1.3)	0 (0)	
Local treatment, n (%)				
Surgery	24 (17.6)	12 (16)	12 (20)	0.601
TARE, TACE, or RFA	33 (24.3)	21 (28)	11 (18.3)	0.160
Best response to first-line treatment, n (%)				
Complete	14 (10.3)	4 (5.3)	10 (16.7)	
Partial	70 (51.5)	40 (53.3)	29 (48.3)	
Stable	36 (26.5)	20 (26.7)	16 (26.7)	0.133
Progression	11 (8.1)	8 (10.7)	3 (5)	
Unknown	5 (3.7)	3 (4)	2 (3.3)	

LDH: Lactate dehydrogenase, ULN: Upper limit of normal, 5-FU: 5-fluorouracil, OX: Oxaliplatin, EGFR: Epidermal growth factor receptor, IRI: Irinotecan, TARE: Transarterial radioembolization, TACE: Transarterial chemoembolization, RFA: Radiofrequency ablation

the presence and burden of liver metastases in synchronous mCRC and correlated with serum CEA levels. High serum LDH levels were associated with worse OS and poorer response to 5-FU-platinum chemotherapy in liver mCRC. Tumor gene expression profiles were associated with microsatellite stability, hypoxia, metabolic pathways, and mesenchymal features, but not with TMB or aneuploidy scores.

The prognostic role of serum LDH in mCRC has been evaluated in several studies. In a meta-analysis, high LDH levels were associated with poor OS [hazard ratio (HR)=1.75 (95% CI: 1.52-2.02)].[15] The prognostic significance was independent of metastatic status and the use of antiangiogenic chemotherapy. No prognostic value was observed for PFS. However, the studies included in this meta-analysis were heterogeneous, reinforcing the rationale for subgroup specification, as addressed in the present study. Additionally, dynamic changes in serum LDH levels have been reported to be prognostic in mCRC.[16] Another meta-analysis demonstrated that high serum LDH levels were associated with shorter PFS [HR=1.43 (95% CI: 1.05-1.94), p=0.023] and OS [HR=1.667 (95% CI: 1.230-2.259), p=0.001] in patients with mCRC treated with bevacizumab-based first-line chemotherapy.[17] High serum LDH levels were also identified as a prognostic factor for worse survival in patients with mCRC receiving irinotecan-based second-line chemotherapy.[18] Our findings confirm the prognostic value of LDH in mCRC and further support its potential utility in microsatellite-stable (MSS), liver-metastatic disease.

Several previous studies have reported molecular features associated with LDH in CRC, largely consistent with our findings. Tumor gene expression of LDHA, vascular endothelial growth factor receptor 1, and vascular endothelial growth factor A has been shown to correlate with serum LDH levels in mCRC.[19] Expression profiling of invasion margins in colorectal tumors has revealed increased lactate metabolism and expression in aggressive phenotypes, supporting a role in epithelial-mesenchymal transition.[20,21] Cetuximab-resistant CRC cells have been reported to produce significantly elevated levels of lactate, suggesting that enhanced anaerobic metabolism is a

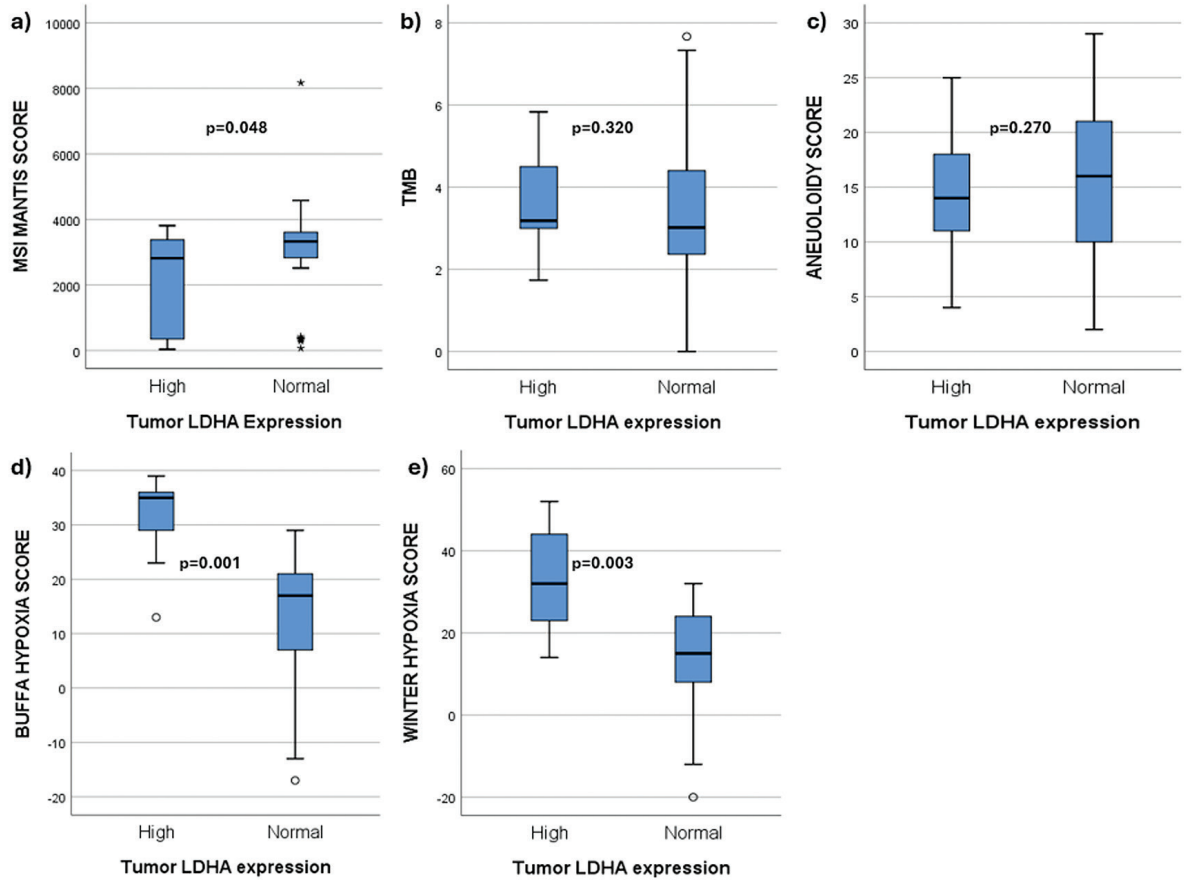

Figure 4. Molecular comparisons between LDHA high- and normal-expression groups: (a) MSI MANTIS score, (b) tumor mutational burden (TMB), (c) aneuploidy score, (d) Buffa hypoxia score, and (e) Winter hypoxia score.

LDHA: Lactate dehydrogenase A, MSI: Microsatellite instability, MANTIS: Microsatellite Analysis for Normal-Tumor InStability

prominent feature of resistance to anti-epidermal growth factor receptor therapy.[22] Notably, inhibition of LDHA by microRNA-34a has been shown to resensitize colon cancer cells to 5-FU.[23] Consistent with these findings, we observed that patients who did not respond to 5-FU–platinum doublet chemotherapy had increased serum LDH levels. Together, these results suggest that elevated LDH levels may indicate a need for more aggressive treatment strategies and the addition of biologic agents to chemotherapy, highlighting the link between LDH and molecular pathogenesis.

In a study comparing the expression of aerobic glycolysis-related genes between primary tumors and liver metastases in CRC, LDHA was the only gene expressed at an elevated level in liver metastases.[24] In line with this observation, our study demonstrated an association between elevated serum LDH levels and both the presence and burden of liver metastases.

The Colorectal Cancer Subtyping Consortium evaluated high-throughput transcriptomic data to define intrinsic molecular subtypes of CRC.[11] Four CMSs were identified, each with distinct characteristics: CMS1 (MSI immune, 14%), characterized by hypermutation, MSI, and strong immune activation; CMS2 (canonical, 37%), epithelial tumors with marked activation of Wingless-related integration site signaling and myelocytomatosis oncogene signaling; CMS3 (metabolic, 13%), epithelial tumors with evident metabolic dysregulation; and CMS4 (mesenchymal, 23%), characterized by prominent transforming growth factor-β activation, stromal invasion, and angiogenesis. Based on our clinical findings and initial molecular analyses, LDH appeared to be more closely associated with CMS3 (metabolic) and CMS4 (mesenchymal) than with CMS1 (MSI immune) or CMS2 (canonical). Accordingly, we explored associations between LDHA gene expression and metabolic and epithelial-mesenchymal transition pathways. The observed correlations support a link between LDH and CMS3-CMS4 subtypes. Furthermore, correlations with epithelial-mesenchymal transition pathway genes suggest that LDH may contribute to epithelial-mesenchymal transition in CRC, thereby facilitating metastatic spread, consistent with its clinical association with liver metastasis and metastatic burden in our cohort.

Although the efficacy of immunotherapy in MSI-high CRC has been well established and has substantially altered treatment paradigms, ongoing research is focused on extending immunotherapy to MSS CRC. A major challenge in this setting is the identification of biomarkers that can select patients with MSS CRC who may benefit from immunotherapy.[25] Our hypothesis-generating findings suggest that LDH may warrant further investigation as a potential biomarker in immunotherapy research for this patient population.

Study Limitations

This study has several limitations. First, the clinical analyses are subject to the inherent limitations of a single-center retrospective design. As all eligible patients during the study period were included, a formal sample size calculation was not performed; however, studies with larger cohorts would provide more robust conclusions. Survival analyses comparing high and normal LDH groups were restricted to patients with liver metastases, as this was the primary difference in baseline characteristics and treatment patterns. Nonetheless, the single-center design and exclusion of certain patients introduce a potential risk of selection bias. Future studies incorporating multicenter cohorts, multivariable-adjusted analyses, and a broader set of clinical variables may strengthen the proposed associations. In addition, matched clinical and molecular analyses were not available. Molecular assessments were primarily based on correlative gene expression analyses. Mechanistic studies and prospective validation cohorts are needed to confirm these findings and establish definitive conclusions.

Conclusion

This study adds to the existing literature on LDH in mCRC by identifying a clinically and molecularly relevant patient subgroup. LDH may serve as a potential tumor marker in MSS, non-immunogenic, liver-dominant mCRC. Based on the hypothesis-generating results of this study, the potential role of LDH as a biomarker in immunotherapy research for MSS CRC warrants evaluation in future studies.

Acknowledgment

The data of this study was partly presented as a poster at ESMO Gastrointestinal Cancers Congress 2024, in Munich, Germany, from 26 to 29 June 2024.

The results published here are in part based upon data generated by the TCGA Research Network: https://www.cancer.gov/tcga.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the Clinical Research Ethics Committee of Ankara University Faculty of Medicine (decision no.: İ11-694-22, date: 10.01.2023) in compliance with the Declaration of Helsinki.

Informed Consent: The study analysed retrospective, anonymous clinical data of the patients. Therefore, informed consent of the patients was not required, and waiver/exempt was granted by the Ethics Committee for this purpose.

Footnotes

Authorship Contributions

Concept: E.A., B.B.K., U.T., G.U., Design: E.A., B.B.K., U.T., G.U., Data Collection or Processing: E.A., B.B.K., U.T., Analysis or Interpretation: E.A., B.B.K., G.U., Literature Search: E.A., Writing: E.A., B.B.K., U.T., G.U.

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REFERENCES

1. Biller LH, Schrag D. Diagnosis and treatment of metastatic colorectal cancer: a review. JAMA. 2021;325:669-685.
2. Cervantes A, Adam R, Roselló S, Arnold D, Normanno N, Taïeb J, Seligmann J, De Baere T, Osterlund P, Yoshino T, Martinelli E; ESMO Guidelines Committee. Electronic address: clinicalguidelines@esmo.org. Metastatic colorectal cancer: ESMO Clinical Practice Guideline for diagnosis, treatment and follow-up. Ann Oncol. 2023;34:10-32.
3. Giannopoulou N, Constantinou C. Recent developments in diagnostic and prognostic biomarkers for colorectal cancer: a narrative review. Oncology. 2023;101:675-684.
4. Khan F, Lin Y, Ali H, Pang L, Dunterman M, Hsu WH, Frenis K, Grant Rowe R, Wainwright DA, McCortney K, Billingham LK, Miska J, Horbinski C, Lesniak MS, Chen P. Lactate dehydrogenase a regulates tumor-macrophage symbiosis to promote glioblastoma progression. Nat Commun. 2024;15:1987.
5. Scartozzi M, Giampieri R, Maccaroni E, Del Prete M, Faloppi L, Bianconi M, Galizia E, Loretelli C, Belvederesi L, Bittoni A, Cascinu S. Pre-treatment lactate dehydrogenase levels as predictor of efficacy of first-line bevacizumab-based therapy in metastatic colorectal cancer patients. Br J Cancer. 2012;106:799-804.
6. Cerami E, Gao J, Dogrusoz U, Gross BE, Sumer SO, Aksoy BA, Jacobsen A, Byrne CJ, Heuer ML, Larsson E, Antipin Y, Reva B, Goldberg AP, Sander C, Schultz N. The cBio cancer genomics portal: an open platform for exploring multidimensional cancer genomics data. Cancer Discov. 2012;2:401-4. doi: 10.1158/2159-8290.CD-12-0095. Erratum in: Cancer Discov. 2012;2:960.
7. Kautto EA, Bonneville R, Miya J, Yu L, Krook MA, Reeser JW, Roychowdhury S. Performance evaluation for rapid detection of pan-cancer microsatellite instability with MANTIS. Oncotarget. 2017;8:7452-7463.
8. Buffa FM, Harris AL, West CM, Miller CJ. Large meta-analysis of multiple cancers reveals a common, compact and highly prognostic hypoxia metagene. Br J Cancer. 2010;102:428-35. doi: 10.1038/sj.bjc.6605450. Erratum in: Br J Cancer. 2010;103:929.
9. Winter SC, Buffa FM, Silva P, Miller C, Valentine HR, Turley H, Shah KA, Cox GJ, Corbridge RJ, Homer JJ, Musgrove B, Slevin N, Sloan P, Price P, West CM, Harris AL. Relation of a hypoxia metagene derived from head and neck cancer to prognosis of multiple cancers. Cancer Res. 2007;67:3441-9. doi: 10.1158/0008-5472.CAN-06-3322. Erratum in: Cancer Res.2009;69:1695.
10. Taylor AM, Shih J, Ha G, Gao GF, Zhang X, Berger AC, Schumacher SE, Wang C, Hu H, Liu J, Lazar AJ; Cancer Genome Atlas Research Network; Cherniack AD, Beroukhim R, Meyerson M. Genomic and functional approaches to understanding cancer aneuploidy. Cancer Cell. 2018;33:676-689.e3.
11. Guinney J, Dienstmann R, Wang X, de Reyniès A, Schlicker A, Soneson C, Marisa L, Roepman P, Nyamundanda G, Angelino P, Bot BM, Morris JS, Simon IM, Gerster S, Fessler E, De Sousa E Melo F, Missiaglia E, Ramay H, Barras D, Homicsko K, Maru D, Manyam GC, Broom B, Boige V, Perez-Villamil B, Laderas T, Salazar R, Gray JW, Hanahan D, Tabernero J, Bernards R, Friend SH, Laurent-Puig P, Medema JP, Sadanandam A, Wessels L, Delorenzi M, Kopetz S, Vermeulen L, Tejpar S. The consensus molecular subtypes of colorectal cancer. Nat Med. 2015;21:1350-1356.
12. Kanehisa M, Goto S. KEGG: kyoto encyclopedia of genes and genomes. Nucleic Acids Res. 2000;28:27-30.
13. Subramanian A, Tamayo P, Mootha VK, Mukherjee S, Ebert BL, Gillette MA, Paulovich A, Pomeroy SL, Golub TR, Lander ES, Mesirov JP. Gene set enrichment analysis: a knowledge-based approach for interpreting genome-wide expression profiles. Proc Natl Acad Sci U S A. 2005;102:15545-15550.
14. Liberzon A, Birger C, Thorvaldsdóttir H, Ghandi M, Mesirov JP, Tamayo P. The molecular signatures database (MSigDB) hallmark gene set collection. Cell Syst. 2015;1:417-425.
15. Li G, Wang Z, Xu J, Wu H, Cai S, He Y. The prognostic value of lactate dehydrogenase levels in colorectal cancer: a meta-analysis. BMC Cancer. 2016;16:249.
16. Ding H, Yuan M, Yang Y, Gupta M, Xu XS. Evaluating prognostic value of dynamics of circulating lactate dehydrogenase in colorectal cancer using modeling and machine learning. Clin Pharmacol Ther. 2024;115:805-814.
17. Feng W, Wang Y, Zhu X. Baseline serum lactate dehydrogenase level predicts survival benefit in patients with metastatic colorectal cancer receiving bevacizumab as first-line chemotherapy: a systematic review and meta-analysis of 7 studies and 1,219 patients. Ann Transl Med. 2019;7:133.
18. Shitara K, Matsuo K, Yokota T, Takahari D, Shibata T, Ura T, Inaba Y, Yamaura H, Sato Y, Najima M, Muro K. Prognostic factors for metastatic colorectal cancer patients undergoing irinotecan-based second-line chemotherapy. Gastrointest Cancer Res. 2011;4:168-172.
19. Azuma M, Shi M, Danenberg KD, Gardner H, Barrett C, Jacques CJ, Sherod A, Iqbal S, El-Khoueiry A, Yang D, Zhang W, Danenberg PV, Lenz HJ. Serum lactate dehydrogenase levels and glycolysis significantly correlate with tumor VEGFA and VEGFR expression in metastatic CRC patients. Pharmacogenomics. 2007;8:1705-1713.
20. Thorn CC, Freeman TC, Scott N, Guillou PJ, Jayne DG. Laser microdissection expression profiling of marginal edges of colorectal tumours reveals evidence of increased lactate metabolism in the aggressive phenotype. Gut. 2009;58:404-412.
21. Mizuno Y, Hattori K, Taniguchi K, Tanaka K, Uchiyama K, Hirose Y. Intratumoral heterogeneity of glutaminase and lactate dehydrogenase a protein expression in colorectal cancer. Oncol Lett. 2020;19:2934-2942.
22. Monteleone F, Rosa R, Vitale M, D'Ambrosio C, Succoio M, Formisano L, Nappi L, Romano MF, Scaloni A, Tortora G, Bianco R, Zambrano N. Increased anaerobic metabolism is a distinctive signature in a colorectal cancer cellular model of resistance to antiepidermal growth factor receptor antibody. Proteomics. 2013;13:866-877.
23. Li X, Zhao H, Zhou X, Song L. Inhibition of lactate dehydrogenase A by microRNA-34a resensitizes colon cancer cells to 5-fluorouracil. Mol Med Rep. 2015;11:577-582.
24. Graziano F, Ruzzo A, Giacomini E, Ricciardi T, Aprile G, Loupakis F, Lorenzini P, Ongaro E, Zoratto F, Catalano V, Sarti D, Rulli E, Cremolini C, De Nictolis M, De Maglio G, Falcone A, Fiorentini G, Magnani M. Glycolysis gene expression analysis and selective metabolic advantage in the clinical progression of colorectal cancer. Pharmacogenomics J. 2017;17:258-264.
25. Williams CJM, Peddle AM, Kasi PM, Seligmann JF, Roxburgh CS, Middleton GW, Tejpar S. Neoadjuvant immunotherapy for dMMR and pMMR colorectal cancers: therapeutic strategies and putative biomarkers of response. Nat Rev Clin Oncol. 2024;21:839-851. doi: 10.1038/s41571-024-00943-6. Epub 2024 Sep 24. Erratum in: Nat Rev Clin Oncol. 2024;21:903.

Table 1S. Genes with the highest correlation coefficient with LDHA expression

Gene	Spearman's rho	p	Function-pathway
PGK1	0.58	5.95e-9	Phosphoglycerate kinase 1, glycolysis and gluconeogenesis
PSMA1	0.57	1.45e-8	Proteasome 20S Subunit Alpha 1
ELP4	0.56	3.05e-8	Elongator Acetyltransferase Complex Subunit 4, chromatin organization and mesodermal commitment
SAAL1	0.55	6.11e-8	Serum Amyloid A Like 1
RRM1	0.55	6.55e-8	Ribonucleotide Reductase Catalytic Subunit M1, pyrimidine deoxyribonucleotides biosynthesis from CTP and purine nucleotides de novo biosynthesis
ADM	0.54	1.12e-7	Adrenomedullin, GPCR downstream signaling and Presynaptic function of Kainate receptors
AKIP1	0.51	4.94e-7	A-Kinase Interacting Protein 1
COQ2	0.51	8.51e-7	Coenzyme Q2, Polyprenyltransferase, Peroxisomal lipid metabolism and Metabolism of water-soluble vitamins and cofactors
MTCH2	0.50	1.081e-6	Mitochondrial Carrier 2
SAP30	0.50	1.086e-6	Sin3A Associated Protein 30, RNA Polymerase I Promoter Opening and infectious disease
MELK	0.50	1.092e-6	Maternal Embryonic Leucine Zipper Kinase
ALDOA	0.50	1.115e-6	Aldolase, Fructose-Bisphosphate A, glycolysis (BioCyc) and response to elevated platelet cytosolic Ca2+
ANKRD37	0.50	1.266e-6	Ankyrin Repeat Domain 37

LDHA: Lactate dehydrogenase A

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RESEARCH ARTICLE

Surgical and Oncologic Outcomes of Colorectal Cancer Across Age Groups:A Multicenter Retrospective Study from the Turkish Society of Colon and Rectal Surgery Registry

Ahmet Ali Aktaş, Ercüment Gürlüler, Özgen Işık, Tuncay Yılmazlar, Turkish Colorectal Cancer Database Study Group*

Bursa Uludağ University, Department of General Surgery, Bursa, Türkiye

ABSTRACT

Aim: This study aimed to perform a comparative analysis of colorectal surgery outcomes in elderly versus younger age groups of patients with colorectal cancer (CRC).

Method: A total of 1.216 patients who underwent colorectal surgery for malignancy were included in this retrospective database study. Data on preoperative characteristics and operative, postoperative, and histopathological parameters were compared across age groups (<50 years, 50-64 years, 65-79 years, and ≥80 years).

Results: The ≥80 years age group, when compared with younger age groups, was associated with the highest preoperative carcinoembryonic antigen levels (p<0.01) and higher rates of American Society of Anesthesiologists physical status 3 (45.3% vs. 3.4% in <50 years, 11.0% in 50-64 years, and 26.5% in 65-79 years, p<0.001), urgent surgery (16.3% vs. 7.0% in 65-79 years and 5.9% in 50-64 years, p=0.009), tumor perforation (9.3% vs. 2.9% in 65-79 years, p=0.031), and not receiving preoperative neoadjuvant therapy (p<0.001). In both the ≥80 years and 65-79 years age groups, colon cancer was significantly more prevalent (p<0.001), whereas pelvic magnetic resonance imaging (p<0.001) and positron emission tomography/computed tomography utilization (p<0.001) were less common than in younger age groups. No significant difference was noted between age groups in terms of surgical approach, length of operating time, postoperative complications, tumor clinicopathology, and regression scores.

Conclusion: Adopting a transdisciplinary model of care that incorporates comprehensive geriatric assessment tools is important to optimize surgical care in elderly patients with CRC, as appropriately selected individuals can achieve excellent outcomes when managed according to the same standards applied to younger patients.

Keywords: Colorectal cancer, colorectal surgery, neoadjuvant therapy, clinicopathological, postoperative complications, age stratification, elderly

Introduction

Colorectal cancer (CRC) remains a leading cause of cancer mortality, ranking second among individuals aged 60-79 years and third among those aged ≥80 years.[1-3] Although incidence increases with age, recent epidemiological trends show a rising incidence in patients under 50 years.[4,5]

Modern CRC management has evolved into a multimodal therapy combining neoadjuvant chemoradiation, surgery, and adjuvant chemotherapy.[6-9] However, elderly patients present unique challenges due to comorbidities, functional decline, advanced disease presentation, and the increased risk of treatment-related toxicity.[10-12] Consequently, patients aged ≥70 years often receive less aggressive treatment despite potentially curative options.[13-15]

Advancements in laparoscopic techniques and perioperative care have improved surgical safety in elderly patients.[16-18] with recent data showing better short-term survival after resection.[19,20] Yet current evidence remains limited by study design flaws, including a lack of younger control groups and the exclusion of open or emergency cases.[21-23]

There is insufficient data in the literature on age-stratified prospective outcome comparisons in elderly patients. This

Address for Correspondence: Prof. Özgen Işık MD, Bursa Uludağ University, Department of General Surgery, Bursa, Türkiye
E-mail: drozgen006@gmail.com **ORCID ID:** orcid.org/0000-0002-9541-5035
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retrospective study performs an age-stratified analysis of preoperative, intraoperative, and postoperative outcomes in elderly versus younger patients with CRC to address these knowledge gaps.

Materials and Methods

This retrospective cohort study used data from the Turkish Society of Colon and Rectal Surgery (TSCRS) registry, collected from 20 centers. A total of 1.216 patients with CRC who underwent colorectal resection between July 2018 and December 2022 were analyzed. The multicenter registry includes detailed preoperative, intraoperative, and 30-day postoperative outcomes.

All participating centers adhered to the standard definitions in accordance with TSCRS guidelines and received training on data entry protocols. Regular audits were conducted to ensure accuracy and completeness. Ethical approval was obtained from the ethics committee of Republic of Türkiye Bursa Uludağ University Health Research Ethics Committee (decision no. 2025/579-7/12, dated: 19.03.2025). The principles of the Helsinki Declaration were followed, and informed consent was waived due to the retrospective design.

Assessment

Data were collected and compared across age groups (<50, 50-64, 65-79, and ≥80 years) in four main categories: patient and tumor characteristics, surgical parameters, and postoperative outcomes.

Preoperative evaluation included patient demographics (age, sex, body mass index, smoking status), American Society of Anesthesiologists (ASA) classification, comorbidities, family history of CRC or malignancy, and prior abdominal surgery. Tumor-related data consisted of presenting symptoms, tumor location, clinical tumor-node-metastasis (TNM) stage, diagnostic imaging [colonoscopy, pelvic magnetic resonance imaging (MRI), positron emission tomography/computed tomography (PET/CT)], presence of metastasis, carcinoembryonic antigen (CEA) and carbohydrate antigen 19-9 (CA 19-9) levels, and details of neoadjuvant therapy (if administered), including the interval between therapy and surgery. The recorded surgical parameters were the timing and type of surgery, surgeon experience, intraoperative tumor localization, distance from the anal verge, mesorectal dissection margin, additional organ resections, anastomosis or stoma type, operative duration, intraoperative blood loss, erythrocyte suspension transfusion, and intraoperative complications.

Postoperative outcomes assessed within 30 days included surgical site infection (SSI), abscess, evisceration, ileus, and reoperation. Pathological evaluation covered tumor histology, differentiation grade, pathological TNM stage, depth of tumor invasion, perforation status, distal and radial surgical margins, mesorectal dissection quality, and tumor regression score (indicating response to neoadjuvant therapy).

Completeness of data was assessed for each variable; variables with >10% missing data were excluded from analysis or handled using appropriate imputation methods.

Statistical Analysis

Statistical analysis was performed using MedCalc® Statistical Software version 19.7.2 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2021). The Shapiro-Wilk test was used to assess normal distribution. The chi-square test was used for the analysis of categorical variables. The Kruskal-Wallis test with post hoc Bonferroni-corrected Mann-Whitney U test was used to compare more than two independent, non-normally distributed variables. Data were expressed as mean ± standard deviation (SD), median (min-max), and percentage (%) where appropriate. A p-value of <0.05 was considered statistically significant.

Results

Patient Demographics and Baseline Characteristics

The mean ± SD age of patients was 62.8±12.4 years (range: 21-97 years), and men comprised 60.9% of the cohort. Overall, 42.5% of patients were in the 65-79-year age group and 35.9% were in the 50-64-year age group, whereas the <50-year and ≥80-year age groups represented 14.5% and 7.1% of patients, respectively (Table 1).

Comorbidities, ASA status, and family history of colorectal and other malignancies are presented in Table 1.

Preoperative Characteristics

Among patients with available data on presenting symptoms, bleeding (475/475, 100.0%), constipation (393/424, 92.7%), and anemia (191/216, 88.4%) were the most common manifestations (Table 2).

The tumor was located in the colon in 64.7% of patients, and most patients were diagnosed at clinical TNM stage III (40.3%) (Table 2).

A synchronous lesion on colonoscopy was identified in 18.2% of patients (polyp in 14.2%). Pelvic MRI, performed in 26.2% of patients, revealed clinical T3 disease in 61.3% and node-positive status in 69.2% of patients. PET/CT, performed in 38.4% of patients, revealed liver metastasis in 10.6% of patients (Table 2).

Median (min-max) CEA and CA 19-9 levels were 3.0 (0-4,362) ng/mL and 11.0(0-12,000) U/mL, respectively (Table 2).

Preoperative neoadjuvant therapy was administered to 30.9% of patients, most of whom received chemoradiotherapy (22.7%), and it was predominantly applied to those with rectal cancer. Time from neoadjuvant therapy to surgery was a median of 8 weeks (range: 0-72 weeks) (Table 2).

Table 1. Patient demographics and baseline characteristics

Age (year)	Mean ± SD	62.8±12.4
	Median (min-max)	64 (21-97)
Age groups, n (%)	<50 year	176 (14.5)
	50-64 year	437 (35.9)
	65-79 year	517 (42.5)
	≥80 year	86 (7.1)
Gender, n (%)		
Male		740 (60.9)
Female		476 (39.1)
Body mass index (kg/m²), mean ± SD		26.4±4.5
Smoking status, n (%)		
Non-smoker		744 (61.2)
Former smoker		321 (26.4)
Active smoker		151 (12.4)
ASA score, n (%)	1	284 (23.4)
	2	688 (56.6)
	3	230 (18.9)
	4	12 (1.0)
	5	2 (0.2)
Comorbid diseases, n (%)		
Hypertension		463 (88.5)
Diabetes mellitus		254 (74.9)
Coronary artery disease		158 (64.0)
Malignity		53 (38.4)
Chronic obstructive lung disease		52 (35.6)
Congestive heart failure		36 (27.7)
Stroke		27 (22.3)
Chronic renal failure		18 (16.4)
Other		207 (72.1)
Family history of colorectal cancer, n (%)		154 (12.7)
Family history of malignancy, n (%)		154 (12.7)
Lung cancer		75 (6.2)
Breast cancer		47 (3.9)
Gastric cancer		39 (3.2)
Bladder cancer		33 (2.7)
Gynecologic cancer		32 (2.6)
Hepatobiliary cancer		22 (1.8)
Thyroid cancer		6 (0.5)
Other		71 (5.8)
Previous abdominal surgery, n (%)		285 (23.4)

ASA: American Society of Anesthesiologists, SD: Standard deviation

Table 2. Preoperative characteristics

Disease/tumor characteristics, n (%)		
Presenting symptom		
Bleeding (n=475)		475 (100.0)
Constipation (n=424)		393 (92.7)
Anemia (n=216)		191 (88.4)
Abdominal pain (n=664)		531 (43.7)
Incidental diagnosis (n=89)		58 (65.2)
Diagnosis by screening (n=158)		99 (62.7)
Location of tumor		
Rectum		428 (35.2)
Colon		787 (64.7)
Clinical T stage	T1	78 (6.4)
	T2	213 (17.5)
	T3	669 (55.0)
	T4	256 (21.1)
Lymph node (N) status	Node negative	584 (48.0)
	Node positive	632 (52.0)
Metastasis (M) status	M0	1056 (87.0)
	M1	158 (13.0)
Clinical TNM stage	I	178 (17.6)
	II	295 (29.1)
	III	408 (40.3)
	IV	132 (13.0)
Imaging findings, n (%)		
Synchronous lesion on colonoscopy		221 (18.2)
Polyp		173 (14.2)
Cancer		48 (3.9)
Pelvic MRI utilization		318 (26.2)
MRI T stage	T1	11 (3.5)
	T2	56 (17.6)
	T3	195 (61.3)
	T4	56 (17.6)
MRI N stage	Node negative	98 (30.8)
	Node positive	220 (69.2)
PET-CT utilization		466 (38.4)
Liver metastasis at diagnosis, n (%)		129 (10.6)
Lung metastasis at diagnosis, n (%)		39 (3.2)
Other metastases at diagnosis, n (%)		15 (1.2)
Laboratory findings, median (min-max)		
CEA (ng/mL) (n=918)		3.0 (0-4,362)
CA 19-9 (U/mL) (n=806)		11.0 (0-12,000)

Table 2. Continued

Disease/tumor characteristics, n (%)	
Treatment characteristics	
Preoperative neoadjuvant therapy, n (%)	
No	839 (69.1)
Yes	375 (30.9)
Type of neoadjuvant therapy, n (%)	
Radiotherapy	29 (2.4)
Chemotherapy	70 (5.8)
Chemoradiotherapy	276 (22.7)
Neoadjuvant therapy-surgery interval (weeks) (n=375), median (min-max)	8 (0-72)

CEA: Carcinoembryonic antigen, Positron emission tomography/computed tomography, MRI: Magnetic resonance imaging, TNM: Tumor-node-metastasis

Operative and Postoperative Characteristics

The majority of patients underwent elective colorectal surgery (92.8%) performed by a specialist (94.1%) using either an open (51.6%) or laparoscopic (43.8%) approach. Low anterior resection (32.1%), anterior resection (25.2%), and right hemicolectomy (16.7%) were the most common surgical procedures (Table 3).

The rectum (31.9%) and sigmoid colon (20.8%) were the most frequent intraoperative tumor locations. Anastomosis was performed in 88.7% of patients (mechanical stapling in 81.3%), whereas a stoma was created in 31.2% of patients (loop ileostomy in 23.6%) (Table 3).

The median operating time was 170 minutes (range: 45-625 minutes). Spleen injury (25.6%), ureter injury (14.3%), and bladder injury (12.2%) were the most common intraoperative complications (Table 3).

Occurring in 32.4% of patients, postoperative complications included SSI (14.0%), ileus (7.6%), reoperation (6.6%), abscess (2.6%), and evisceration (1.6%) (Table 3).

Tumor Histopathology and Regression Scores Related to Neoadjuvant Therapy

Adenocarcinoma was the predominant histological type (87.3%), and 47.0% of tumors were moderately differentiated. Pathological TNM staging revealed stage II (28.4%) or stage III (26.7%) disease in most patients (Table 4).

Lymphatic, vascular, and perineural tumor invasion were present in 48.0%, 38.3%, and 25.1% of patients, respectively. Tumor perforation was observed in 4.4% of patients. A positive radial surgical margin was found in 3.5%, and partial mesorectal dissection margin involvement was noted in 23.0% of patients (Table 4).

Different scoring systems for assessing neoadjuvant therapy response and relevant results are given in Table 4. Preoperative characteristics by age group

In the ≥80 years age group, ASA 3 status (45.3% vs. 3.4% in the <50 years, 11.0% in the 50-64 years, and 26.5% in the 65-79 years age groups, p<0.001) was significantly more common, whereas family history of CRC (3.5% vs. 14.9% in the 50-64 years and 17.6% in the <50 years age groups, p=0.002) and presentation with constipation (80.6% vs. 95.9% in the 65-79 years age group, p=0.004) were significantly less common than in younger age groups (Table 5).

In both the ≥80 years and 65-79 years age groups, colon cancer was significantly more prevalent (80.2% and 69.1%, respectively, vs. 59.7% in the 50-64 years and 56.8% in the <50 years age groups, p<0.001), whereas pelvic MRI utilization (12.8% and 21.3%, respectively, vs. 31.6% in the 50-64 years and 33.5% in the <50 years age group, p<0.001) and PET-CT utilization (30.6% and 32.2%, respectively, vs. 45.5% in the 50-64 years and 45.5% in the <50 years age groups, p<0.001) were less common than in younger age groups (Table 5).

The ≥80 years age group had the highest preoperative CEA levels [median (min-max) 6.5 (1-157) ng/mL, p<0.01], and the <50 years age group had the lowest [median (min-max) 2.0 (0-1,000) ng/mL, p<0.01] compared with other age groups (Table 5).

A total of 375 patients (30.9%), the vast majority of whom had rectal cancer, received neoadjuvant therapy. Patients in the ≥80 years age group were more likely to have had no preoperative neoadjuvant therapy (87.2% vs. 74.5% in the 65-79 years, 62.5% in the 50-64 years, and 61.4% in the <50 years age groups, p<0.001) or were less likely to have received neoadjuvant chemoradiotherapy (5.8% vs. 18.0% in the 65-79 years, 29.3% in the 50-64 years, and 28.4% in the <50 years age groups, p<0.001) than younger age groups (Table 5).

Table 3. Operative and postoperative characteristics

Colorectal surgery	
Timing of surgery, n (%)	
Urgent	88 (7.2)
Elective	1.128 (92.8)
Performing surgeon, n (%)	
Specialist	1.144 (94.1)
Fellow	72 (5.9)
Type of surgery, n (%)	
Open surgery	628 (51.6)
Laparoscopic surgery	532 (43.8)
Hand-assisted laparoscopic surgery	4 (0.3)
Robotic surgery	52 (4.3)
Surgical intervention, n (%)	
Low anterior resection	390 (32.1)
Anterior resection	306 (25.2)
Right hemicolectomy	203 (16.7)
Extended right hemicolectomy	79 (6.5)
Subtotal colectomy	76 (6.3)
Left hemicolectomy	75 (6.2)
Abdominoperineal resection	74 (6.1)
Total proctocolectomy	13 (1.1)
Intraoperative characteristics	
Intraoperative location of tumor, n (%)	
Rectum	388 (31.9)
Sigmoid colon	253 (20.8)
Rectosigmoid	169 (13.9)
Ascending colon	111 (9.1)
Cecum	104 (8.6)
Hepatic flexure	62 (5.1)
Transverse colon	48 (3.9)
Descending colon	45 (3.7)
Splenic flexure	36 (3.0)
Tumor distance to anal verge (n=384), median (min-max)	7.0 (0.0-15.0)
Mesorectal dissection margin, n (%)	
Partial	132 (10.9)
Total	278 (22.9)
Same session additional surgical intervention, n (%)	186 (15.3)
Cholecystectomy	59 (4.9)
Incisional hernia	1 (0.1)
Inguinal hernia	3 (0.2)
Other	123 (10.1)

Table 3. Continued

Intraoperative characteristics	
Additional organ resection due to tumor invasion, n (%)	114 (9.4)
Anastomosis (n=1,142), n (%)	1,078 (88.7)
Mechanical stapling	988 (81.3)
Hand-sewn	90 (7.4)
Stoma (n=1,145), n (%)	379 (31.2)
Loop ileostomy	287 (23.6)
End stoma	57 (4.7)
Double barrel stoma	16 (1.3)
Loop colostomy	12 (1.0)
Other	7 (0.6)
Length of operating time (min), median (min-max)	170.0 (45.0-625.0)
Intraoperative complications, n (%)	
Spleen injury	11(25.6)
Ureter injury	6 (14.3)
Bladder injury	5 (12.2)
Small intestine injury	4 (9.8)
Pancreatic injury	4 (9.8)
Proximal colon ischemia	3 (7.7)
Presacral bleeding	2 (5.3)
Colon injury	2 (5.1)
Liver injury	2 (5.1)
Iliac vessel injury	1 (2.7)
Duodenal injury	1 (2.6)
Other	6 (14.6)
Estimated blood loss (mL), median (min-max)	100.0 (0.0-1,500.0)
Intraoperative use of erythrocyte suspension, n (%)	64 (5.3)
Postoperative complications, n (%)	394 (32.4)
Surgical site infection	170 (14.0)
Ileus	92 (7.6)
Reoperation	80 (6.6)
Abscess	32 (2.6)
Evisceration	20 (1.6)

No significant difference was noted between age groups in terms of previous abdominal surgery, incidental or screening-based diagnosis rates, clinical TNM stage, or presence of synchronous lesions on colonoscopy (Table 5).

Type of surgery and postoperative complications by age group

In the ≥80 years age group, urgent surgery was significantly more common than in the 65-79 years and 50-64 years age groups (16.3% vs. 7.0% and 5.9%, respectively, p=0.009). No significant difference was noted between age groups in terms of surgical approach (open, laparoscopic, robotic, or hand-assisted laparoscopic surgery) and length of operating time (Table 6).

No significant difference was noted between age groups in terms of postoperative complications (Table 6). Tumor histopathology and tumor regression scores by age group

In the ≥80 years age group, tumor perforation was significantly more common than in the 65-79 years age group (9.3% vs. 2.9%, p=0.031) (Table 7).

Table 4. Tumor histopathology and neoadjuvant therapy regression scores

Histological type, n (%)	
Adenocarcinoma	1.068 (87.3)
Mucinous	131 (10.8)
Signet-ring cell	10 (0.8)
Medullary	1 (0.1)
Tumor differentiation, n (%)	
Unknown	160 (13.2)
Poorly differentiated	168 (13.8)
Moderately differentiated	572 (47.0)
Well-differentiated	308 (25.3)
Pathological TNM staging, n (%)	
T stage	
T0	71 (5.8)
Tis	5 (0.4)
T1	63 (5.2)
T2	155 (12.8)
T3	609 (50.1)
T4a	245 (20.2)
T4b	68 (5.6)
N stage	
N0	**693 (57.0)**
N1a	**116 (9.5)**
N1b	**142 (11.7)**
N1c	**32 (2.6)**
N2a	**106 (8.7)**
N2b	**127 (10.4)**
M stage	
M0	1,053 (86.6)
M1a	108 (8.9)
M1b	29 (2.4)
M1c	26 (2.1)
Pathological TNM stage	
0	56 (4.6)
I	147 (12.1)
IIa	276 (22.7)
IIb	54 (4.4)
IIc	16 (1.3)
IIIa	26 (2.1)
IIIb	191 (15.7)
IIIc	109 (8.9)
IVa	90 (7.4)
IVb	20 (1.6)
IVc	23 (1.9)

Table 4. Continued

Tumor invasion, n (%)	
Lymphatic invasion	584 (48.0)
Vascular invasion	466 (38.3)
Perineural invasion	305 (25.1)
Tumor perforation	54 (4.4)
Surgical margins, n (%)	
Radial surgical margin involvement, n (%)	42 (3.5)
Mesorectal dissection quality, n (%)	
Partial	280 (23.0)
Total	26 (2.1)
Tumor regression score, n (%)	
AJCC (Modified Ryan) scale	125 (10.3)
0 (complete response)	22 (17.6)
1 (near complete response)	26 (20.8)
2 (partial response)	48 (38.4)
3 (poor or no response)	29 (23.2)
Dworak scale	77 (6.3)
0 (no response)	2 (2.6)
1 (minimal response)	12 (15.6)
2 (moderate response)	26 (33.8)
3 (near complete response)	19 (24.7)
4 (complete response)	18 (23.4)
Mandard scale	71 (5.8)
1 (no residual carcinoma)	17 (23.9)
2 (<10% residual carcinoma)	11 (15.5)
3 (10%-50% residual carcinoma)	27 (38.0)
4 (>50% residual carcinoma, outgrowing fibrosis)	9 (12.7)
5 (>50% residual carcinoma, no regressive changes)	7 (9.8)
Ryan scale	42 (3.5)
1 (good)	9 (21.4)
2 (moderate)	21 (50.0)
3 (poor)	12 (28.6)
Modified Dworak scale	5 (0.4)
5 (no response)	0
4 (minimal response)	0
3 (moderate response)	3 (60.0)
2 (near complete response)	2 (40.0)
1 (complete response)	0(0.0)

AJCC: American Joint Committee on Cancer, TNM: Tumor-node-metastasis

Table 5. Preoperative characteristics by age group

	<50 year (n=176)	50-64 year (n=437)	65-79 year (n=517)	≥80 year (n=86)	p-value[1]
ASA score					
1	112 (63.6)[a]	122 (27.9)[a]	46 (8.9)	4 (4.7)	
2	58 (33.0)	265 (60.6)[a]	327 (63.2)[a]	38 (44.2)	
3	6 (3.4)[a]	48 (11.0)[a]	137 (26.5)[a]	39 (45.3)	**<0.001**
4	0(0.0)	2 (0.5)	6 (1.2)	4 (4.7)	
5	0(0.0)	0 (0.0)	1 (0.2)	1 (1.2)	
Presenting symptom					
Bleeding (n=475)	79 (100)	179 (100)	185 (100)	28 (100)	-
Constipation (n=424)					
No	8 (12.3)	8 (6.3)	8 (4.1)	7 (19.4)	**0.004**
Yes	57 (87.7)	119 (93.7)	188 (95.9)[a]	29 (80.6)	
Abdominal pain (n=664)					
No	0	6 (3)	13 (6)	2 (4)	0.088
Yes	87(100.0)	191 (97.0)	205 (94.0)	48 (96.0)	
Anemia (n=216)					
No	4(18.2)	5 (9.1)	12 (10.5)	4 (16)	0.600
Yes	18(81.8)	50 (90.9)	102 (89.5)	21 (84)	
Screening (n=158)					
No	9(47.4)	21 (33.3)	23 (34.8)	6 (60.0)	0.306
Yes	10(52.6)	42 (66.7)	43 (65.2)	4 (40.0)	
Incidental (n=89)					
No	6(54.5)	9 (30)	12 (28.6)	4 (66.7)	0.133
Yes	5(45.5)	21(70.0)	30 (71.4)	2 (33.3)	
Family history of colorectal cancer					
Yes	31 (17.6)[a]	65 (14.9)[a]	55 (10.6)	3 (3.5)	**0.002**
No	145 (82.4)	371 (84.9)	462 (89.4)	83 (96.5)	
Previous abdominal surgery					
Yes	34 (19.3)	108 (24.8)	119 (23.1)	24 (27.9)	0.380
No	142 (80.7)	328 (75.2)	396 (76.9)	62 (72.1)	
Tumor location					
Colon	100 (56.8)[a,b]	261(59.7)[a,b]	357 (69.1)	69 (80.2)	**<0.001**
Rectum	76 (43.2)	176 (40.3)	159 (30.8)	17 (19.8)	
Clinical T stage					
I	10 (5.7)	37 (8.5)	28 (5.4)	3 (3.5)	
II	25 (14.2)	76 (17.4)	93 (18)	19 (22.1)	0.151
III	93 (52.8)	246 (56.3)	286 (55.3)	44 (51.2)	
IV	48 (27.3)	78 (17.8)	110 (21.3)	20 (23.3)	

Table 5. Continued

	<50 year (n=176)	50-64 year (n=437)	65-79 year (n=517)	≥80 year (n=86)	p-value[1]
Clinical N stage					
0	75 (42.6)	205 (46.9)	258 (49.9)	46 (53.5)	0.257
I	101 (57.4)	232 (53.1)	259 (50.1)	40 (46.5)	
Clinical M stage					
0	148 (84.6)	381 (87.4)	453 (87.6)	74 (86)	0.750
I	27 (15.4)	55 (12.6)	64 (12.4)	12 (14)	
Clinical TNM stage					
I	22(15.7)	70 (19.2)	73 (16.9)	13 (17.3)	0.649
II	35(25)	100 (27.4)	135 (31.2)	25 (33.3)	
III	58(41.4)	152 (41.6)	171 (39.5)	27 (36.0)	
IV	25(17.9)	43 (11.8)	54 (12.5)	10 (13.3)	
Laboratory findings, median (min-max)					
CEA (ng/mL) (n=918)	2.0 (0-1,000)[aa]	3.0 (0-4,362)[aa,c]	3.0 (01,462)[aa,c]	6.5 (1-157)[c]	**0.002[2]**
CA 19-9 (U/mL) (n=806)	8.0 (0-6,520)	11 (0-12,000)	11 (0-1,751)	11 (1-2,000)	0.654[2]
Synchronous lesion on colonoscopy, n (%)					
Cancer	9 (5.1)	16 (3.7)	18 (3.5)	5 (5.8)	0.703
Polyp	21(11.9)	67 (15.3)	76 (14.7)	9 (10.5)	
None	146 (83)	354 (81)	423 (81.8)	72 (83.7)	
MRI T stage					
1	1 (1.7)	7 (5.1)	3 (2.7)	0	NA
2	8 (13.6)	25 (18.1)	20 (18.2)	3(27.3)	
3	36 (61)	85 (61.6)	68 (61.8)	6(54.5)	
4	14 (23.7)	21(15.2)	19 (17.3)	2(18.2)	
MRI N stage					
Node positive	47 (79.7)	93 (67.4)	72 (65.5)	8 (72.7)	0.258
Node negative	12 (20.3)	45 (32.6)	38 (34.5)	3 (27.3)	
Preoperative neoadjuvant therapy					
Chemoradiotherapy	50 (28.4)[a]	128 (29.3)[a]	93 (18.0)[a]	5 (5.8)	**<0.001**
Chemotherapy	12 (6.8)	30 (6.9)	27 (5.2)	1 (1.2)	
Radiotherapy	6 (3.4)	6 (1.4)	12 (2.3)	5 (5.8)[a]	
None	108 (61.4)[a]	273 (62.5)[a]	385 (74.5)[a]	75 (87.2)	

[1]Chi-square test, [2]Kruskal-Wallis test with post-hoc Bonferroni-corrected Mann-Whitney U test

[a] p<0.05 and [aa]p<0.01 compared with the ≥80 years age group, [b]p<0.05 compared with the 65-79 years age group, [c]p < 0.01 compared with the <50 year group. MRI: Magnetic resonance imaging, TNM: Tumor-node-metastasis, ASA: American Society of Anesthesiologists, CEA: Carcinoembryonic antigen, CA: Carbohydrate antigen

Distal margin distance was significantly shorter in both the ≥80 years and 65-79 years age groups than in younger age groups [median (min-max) 21 (0-86)] mm and 20 (0-114) mm, respectively, vs. 22 (0-72) mm in the 50-64 years age group and 26.5 (4-141) mm in the <50 years age group, p=0.008) (Table 7).

No significant difference was noted between age groups in terms of histological type, tumor differentiation, pathological TNM stage, tumor invasion, or tumor regression scores (Table 7).

There was a nonsignificant tendency for less frequent utilization of the Dworak scale in patients aged ≥80 years (0.0% vs. 22.5-27.0% in younger age groups) and more frequent utilization of the American Joint Committee on Cancer (AJCC) (modified Ryan) scale in the youngest (<50 years, 46.0%) and oldest (≥80 years, 50.0%) age groups (Table 7).

Discussion

Our findings in a retrospective cohort of patients undergoing colorectal surgery revealed significant differences in certain preoperative, operative/postoperative, and pathological characteristics across the age groups, which pertained mainly to the very elderly (≥80 years) versus younger age groups. Specifically, patients aged ≥80 years were more likely to have ASA 3 status and high preoperative CEA levels but less

Table 6. Type and timing of surgery and postoperative complications by age group

	<50 year (n=176)	50-64 year (n=437)	65-79 year (n=517)	≥80 year (n=86)	p-value[1]
Timing of surgery, n (%)					
Urgent	12 (6.8)	26 (5.9)[a]	36 (7.0)[a]	14 (16.3)	**0.009**
Elective	164 (93.2)	411 (94.1)	481 (93)	72 (83.7)	
Type of surgery, n (%)					
Open surgery	78 (44.3)	237 (54.2)	267 (51.6)	46 (53.5)	0.167
Laparoscopic surgery	92 (52.3)	181 (41.4)	221 (42.7)	38 (44.2)	
Robotic surgery	6 (3.4)	19 (4.3)	25 (4.8)	2 (2.3)	
Hand-assisted laparoscopic surgery	0 (0.0)	0 (0.0)	4 (0.8)	0(0.0)	
Length of operating time (min), median (min-max)	175 (55-480)	180 (45-620)	170 (50-625)	160 (45-360)	0.273[2]
Postoperative complications, n (%)					
Surgical site infection					
Yes	18 (10.2)	69 (15.8)	70 (13.5)	13 (15.1)	0.312
No	158 (89.8)	368 (84.2)	447 (86.5)	73 (84.9)	
Abscess					
Yes	7 (4.0)	13 (3.0)	8 (1.5)	4 (4.7)	0.159
No	169 (96)	424 (97)	509 (98.5)	82 (95.3)	
Evisceration					
Yes	1 (0.6)	3 (0.7)	14 (2.7)	2 (2.3)	0.055
No	175 (99.4)	434 (99.3)	503 (97.3)	84 (97.7)	
Ileus					
Yes	10 (5.7)	32 (7.3)	45 (8.7)	5 (5.8)	0.519
No	166 (94.3)	405 (92.7)	472 (91.3)	81 (94.2)	
Reoperation					
Yes	10 (5.7)	26 (5.9)	37 (7.2)	7 (8.2)	0.760
No	166 (94.3)	411 (94.1)	480 (92.8)	78 (91.8)	

[1]Chi-square test, [2]Kruskal-Wallis test with post-hoc Bonferroni-corrected Mann-Whitney U test

[a] p<0.05 compared with the ≥80 years age group

Table 7. Tumor histopathology and tumor regression scores by age group

	<50 year (n=176)	50-64 year (n=437)	65-79 year (n=517)	≥80 year (n=86)	p-value
Histological type, n (%)					
Adenocarcinoma NOS	154 (87.5)	378 (87.1)	460 (89.3)	76 (89.4)	0.828[1]
Mucinous	19 (10.8)	53 (12.2)	51 (9.9)	8 (9.4)	
Signet-ring cell	3 (1.7)	3 (0.7)	3 (0.6)	1 (1.2)	
Medullary	0	0	1 (0.2)	0	
Tumor differentiation, n (%)					
Unknown	28 (16)	64 (14.8)	56 (10.9)	12 (14)	0.418[1]
Poorly differentiated	21 (12)	63 (14.5)	70 (13.6)	14 (16.3)	
Moderately differentiated	87 (49.7)	189 (43.6)	253 (49.2)	43 (50.0)	
Well-differentiated	39 (22.3)	117 (27)	135 (26.3)	17 (19.8)	
Pathological TNM staging, n (%)					
T stage					
T0	21 (11.9)	27 (6.2)	21(4.1)	2 (2.3)	N/A
Tis	0 (0.0)	3 (0.7)	1 (0.2)	1 (1.2)	
T1	11 (6.3)	29 (6.6)	22 (4.3)	1 (1.2)	
T2	20 (11.4)	60 (13.7)	66 (12.8)	9 (10.5)	
T3	73 (41.3)	213 (48.7)	276 (53.4)	47 (54.7)	
T4a	37 (21.0)	84 (19.2)	103 (19.9)	21 (24.4)	
T4b	14 (8.0)	21 (4.8)	28 (5.4)	5 (5.8)	
N stage					
N0	96 (54.5)	256 (58.6)	292 (56.5)	49 (57.0)	N/A
N1a	14 (8.0)	40 (9.2)	53 (10.3)	9 (10.5)	
N1b	16 (9.1)	53 (10.3)	64 (12.4)	9 (10.5)	
N1c	5 (2.8)	12 (2.7)	15 (2.9)	0 (0.0)	
N2a	19 (10.8)	36 (8.2)	42 (8.1)	9 (10.5)	
N2b	26 (14.8)	40 (9.2)	51 (9.9)	10 (11.6)	
M stage					
M0	147 (83.5)	378 (86.5)	451(87.2)	77 (89.5)	N/A
M1a	20 (11.4)	39 (8.9)	43 (8.3)	6 (7.0)	
M1b	6 (3.4)	9 (2.1)	11 (2.1)	3 (3.5)	
M1c	3 (1.7)	11 (2.5)	12 (2.3)	0 (0.0)	
TNM stage					
0	15 (10.9)	23 (6.4)	15 (3.5)	3 (4.0)	N/A
1	19 (13.8)	57 (15.7)	65 (15.0)	6 (8.0)	
2a	24 (17.4)	100 (27.6)	126 (29.1)	26 (34.7)	
2b	10 (7.2)	17 (4.7)	21 (4.8)	6 (8.0)	
2c	6 (4.3)	2 (0.6)	8 (1.8)	0 (0.0)	
3a	2 (1.4)	16 (4.4)	7 (1.6)	1 (1.3)	
3b	21 (15.2)	61 (16.9)	94 (21.7)	15 (20.0)	
3c	17 (12.3)	40 (11)	43 (9.9)	9 (12.0)	
4a	18 (13)	32 (8.8)	34 (7.9)	6 (8.0)	
4b	3 (2.2)	4 (1.1)	10 (2.3)	3 (4.0)	
4c	3 (2.2)	10 (2.8)	10 (2.3)	0 (0.0)	

Table 7. Continued

	<50 year (n=176)	50-64 year (n=437)	65-79 year (n=517)	≥80 year (n=86)	p-value
Tumor invasion, n (%)					
Lymphatic invasion					
Yes	88 (50.3)	202 (46.2)	248 (48)	46 (53.5)	0.582[1]
No	87 (49.7)	235 (53.8)	269 (52)	40 (46.5)	
Vascular invasion					
Yes	77 (44.0)	167 (38.2)	189 (36.6)	33 (38.4)	0.381[1]
No	98 (56.0)	270 (61.8)	328 (63.4)	53 (61.6)	
Perineural invasion					
Yes	46 (26.3)	112 (25.6)	128 (24.8)	19 (22.1)	0.887[1]
No	129 (73.7)	325 (74.4)	389 (75.2)	67 (77.9)	
Tumor perforation					
Yes	7 (4.0)	24 (5.5)	15 (2.9)[a]	8 (9.3)	**0.031**
No	168 (96)	412 (94.5)	502 (97.1)	78 (90.7)	
Distal margin distance (mm), median (min-max)	26.5 (4-141)[a,b]	22 (0-72)[a,b]	20 (0-114)	21 (0-86)	0.008[2]
Tumor regression scales, n (%)					
Dworak	17 (27.0)	35 (25.4)	25 (22.5)	0 (0.0)	0.657[1]
Mandard	12 (19.0)	28 (20.3)	28 (25.2)	3 (30.0)	
Ryan	5 (7.9)	19 (13.8)	19 (13.8)	2 (20.0)	
AJCC (Modified Ryan)	29 (46.0)	54 (39.1)	54 (39.1)	5 (50.0)	
Modified Dworak	0 (0.0)	2 (1.4)	2 (1.4)	0 (0.0)	
Dworak score					
0 (no response)	1 (5.9)	1 (2.9)	0 (0.0)	-	0.264[1]
1 (minimal response)	1 (5.9)	7 (20.0)	4 (16.0)	-	
2 (moderate response)	3 (17.6)	13 (37.1)	10 (40.0)	-	
3 (near complete response)	4 (23.5)	9 (25.7)	6 (24.0)	-	
4 (complete response)	8 (47.1)	5 (14.3)	5 (20)	-	
Mandard score					
1 (no residual carcinoma)	5 (41.7)	5 (17.9)	6 (21.4)	1 (33.3)	N/A
2 (<10% residual carcinoma)	1 (8.3)	8 (28.6)	2 (7.1)	0 (0.0)	
3 (10%-50% residual carcinoma)	5 (41.7)	9 (32.1)	11 (39.3)	2 (66.7)	
4 (>50% residual carcinoma, outgrowing fibrosis)	0 (0.0)	3 (10.7)	6 (21.4)	0 (0.0)	
5 (>50% residual carcinoma, no regressive changes)	1 (8.3)	3 (10.7)	3(10.7)	0 (0.0)	
Ryan score					
1 (good)	3 (60)	4 (21.1)	2 (12.5)	0 (0.0)	N/A
2 (moderate)	2 (40)	9 (47.4)	9 (56.3)	1 (50)	
3 (poor)	0 (0.0)	6 (31.6)	5 (31.3)	1 (50)	
Modified Ryan score					
0 (complete response)	4 (14.3)	7 (13)	10 (26.3)	1 (20)	N/A
1 (near complete response)	7 (25)	14 (25.9)	5 (13.2)	0 (0.0)	
2 (partial response)	12 (42.9)	23 (42.6)	12 (31.6)	1 (20)	
3 (poor or no response)	5 (17.9)	10 (18.5)	11(28.6)	3 (60)	

Table 7. Continued

	<50 year (n=176)	50-64 year (n=437)	65-79 year (n=517)	≥80 year (n=86)	p-value
Modified Dworak score					
5 (no response)	-	0 (0.0)	0 (0.0)	-	N/A
4 (minimal response)	-	0 (0.0)	0 (0.0)	-	
3 (moderate response)	-	1(50)	2(66.7)	-	
2 (near complete response)	-	1(50)	1(33.3)	-	
1 (complete response)	-	0(0.0)	0(0.0)	-	

N/A: Not applicable

[1]Chi-square test, [2]Kruskal-Wallis test with post-hoc Bonferroni-corrected Mann-Whitney U test

[a] p<0.05 compared with the ≥80 years age group, [b]p<0.05 compared with the 65-79 years age group, TNM: Tumor-node-metastasis, NOS: Not otherwise specified, AJCC: American Joint Committee on Cancer

likely to present with constipation and to have a positive family history of CRC, whereas both the ≥80 years and 65-79 years age groups were associated with a higher rate of colon cancer, less common utilization of pelvic MRI and PET-CT, and shorter distal margin distance than younger age groups. Notably, patients in the ≥80 years age group were more likely to have tumor perforation and urgent surgery, along with a lesser likelihood of receiving preoperative neoadjuvant therapy overall and neoadjuvant chemoradiotherapy in particular, than younger age groups.

Elderly patients with CRC are considered to be at particular risk of emergency admission, which often necessitates prompt treatment with urgent rather than elective surgery, leading to a higher risk of postoperative complications and perioperative mortality.[1] The more advanced tumor stage and poor physical status (ASA scores ≥3) of elderly patients are also considered additional risk factors in an emergency presentation, alongside the increased frequency of postoperative morbidity and mortality with progressive age.[1,2]

Postoperative complication rates in the ≥80 years age group (36.0%) and in younger age groups (34.5%) in our cohort are consistent with previous colorectal surgery studies, which reported complication rates ranging from 32.7% to 53.7% for patients aged ≥80 years and from 19.7% to 55.9% for younger age groups.[3-8]

Notably, our patients aged ≥80 years had the highest preoperative CEA levels and higher rates of ASA 3 status, tumor perforation, and urgent surgery, along with a higher prevalence of tumors localized to the colon, than younger patients, all of which are considered risk factors for increased postoperative complications and morbidity.[1,9,10] However, despite the presence of these potential risk factors in the elderly group, postoperative complication rates appeared to be similar across the age groups.

Although elderly patients are considered more likely to present with late-stage disease requiring emergency surgery as a risk factor contributing to postoperative morbidity and mortality[2,11], the histological type, tumor differentiation, tumor invasion, and clinical and pathological TNM stages were similar across age groups in our cohort. Although elderly patients are considered more likely to have had previous abdominal surgery, resulting in intra-abdominal adhesions that prolong operative time and increase the risk of iatrogenic injury[12], our findings revealed no significant difference between age groups in terms of the presence of previous abdominal surgery.

Likewise, in a previous study among patients with CRC undergoing elective colorectal surgery, those >80 years of age were found to have significantly higher levels of CEA, higher ASA class, and a higher prevalence of right-sided colon cancer than younger groups, along with no statistical differences in tumor stage or differentiation, laparoscopic versus open surgery, blood loss, or duration of operation between age groups.[9] The authors also reported that patients aged 60-79 years displayed a similar trend to those under 60 years, whereas higher CEA levels in the ≥80 years group were suggested to be caused by more right-sided cancer with malignant potential.[9,13]

Accordingly, although advanced age itself has traditionally been viewed as an independent risk factor for adverse outcomes in colorectal surgery, advancements in minimally invasive surgery and improvements in perioperative care have made colorectal surgery safe and feasible in the elderly. Thus, recent evidence suggests that chronological age alone is not a strict exclusion criterion for curative surgery.[3,9,11,14,15]

In our cohort, no significant difference was noted between age groups in terms of surgical approach (open vs. laparoscopic surgery) or length of operating time. The open surgery (53.5%) and laparoscopic surgery (44.2%) rates in our ≥80 years age group seem notable, given the consideration of laparoscopic-assisted colorectal surgery as a safe and feasible surgical approach with more pronounced benefits (i.e., less

blood loss, reduced morbidity, faster return of bowel function, and shorter length of stay) in the elderly population than open surgery.[11,16-19] In a meta-analysis of 24 studies on colorectal surgery in elderly patients, laparoscopic surgery was associated with a lower risk of postoperative complications and 90-day mortality compared with open surgery, whereas long-term overall survival, disease-free survival, risk of recurrence, and readmission rates were similar between the two surgical approaches.[17] Hence, elderly and younger patients with CRC were reported to share similar outcomes in laparoscopic surgery, with equivalent complication rates, whereas laparoscopic surgery was suggested to be prioritized in elderly patients with CRC given its potential to be more beneficial than open surgery, particularly in this age group.[17,20-22]

Our findings support that elderly patients with CRC should receive management as similar as possible to that of the younger population, with the choice of curative surgery, particularly for those with a reasonable life expectancy.[3,9,11,23-25]

Pelvic MRI and PET-CT are considered valid imaging modalities in CRC, particularly for the detection of distant metastases and locoregional evaluation for preoperative planning.[26] Pelvic MRI helps determine the type of surgery required for curative resection based on the extent of the colorectal tumor within the pelvis and locoregional staging, and it also enables accurate measurement of the distance to the anal verge and accurate preoperative locoregional staging to maximize the benefit of neoadjuvant chemoradiotherapy.[27-29] The less common utilization of these modalities in both the ≥80 years and 65-79 years age groups in our cohort seems notable in this regard, given the higher rate of colon cancer and shorter distal margin distance in these age groups, alongside the less common utilization of neoadjuvant therapy in those aged ≥80 years.

Similar to our results, neoadjuvant therapy was reported to be less commonly used in elderly patients with CRC, attributed to a range of factors such as more emergency presentations, more proximal tumors, increased frailty, and shorter life expectancy in the elderly.[3]

Overall, complete or near-complete response rates to neoadjuvant therapy in our cohort were 38.4% on the AJCC (modified Ryan) scale, 48.1% on the Dworak scale, and 39.4% on the Mandard scale, regardless of age group. This seems notable given the likelihood of better 5-year overall and disease-free survival in good responders (complete or near-complete response) than in poor responders to neoadjuvant therapy.[30] Indeed, older patients were also reported to receive adjuvant therapy less commonly, along with longer delays between surgery and chemotherapy, possibly due to tolerability issues and a potentially low benefit compared with younger patients.[20,31] Given the potential survival benefit of neoadjuvant chemotherapy compared with adjuvant chemotherapy for locally advanced colon cancer—with effective reduction of tumor burden before curative surgery and higher complete pathological response rates without an increase in surgical morbidity—the potential impact of the less common utilization of neoadjuvant therapy on long-term outcomes such as tumor recurrence and survival in the elderly population needs to be further investigated.[3,14,32-35]

A major strength of the present study is the detailed analysis of preoperative, operative, and postoperative data, as well as pathological results, across four age groups in a large real-world sample of colorectal surgery patients registered in the TSCRS CRC database.

However, certain limitations should be acknowledged, such as the retrospective nature of the data obtained from a prospectively maintained national database and the likelihood that a number of older patients were precluded from surgery due to poor performance status and comorbidities. Important geriatric-specific variables such as frailty indices, nutritional status, and cognitive function were not recorded in the TSCRS database, limiting the assessment of physiologic versus chronological age in surgical outcomes. The use of multiple tumor regression grading systems across centers and the small sample sizes in some categories may limit the comparability of treatment responses across age groups. As the study did not include patients who did not undergo surgery, it is likely to introduce surgical control bias, which may lead to an underestimation of disease burden or outcomes in the most vulnerable elderly population. The inclusion of nonoperative elderly patients with CRC in future studies would help close this knowledge gap.

Because the data were obtained from 20 TSCRS-participating centers, which may be high-volume or academic institutions with above-average outcomes, the generalizability to broader clinical settings is limited. Incorporating center-level adjustment in the analysis could help mitigate potential referral center bias. Additionally, conducting the study across multiple centers may have introduced inter-center variability.

Another limitation of the study is the lack of survival or long-term oncologic outcomes. There is also a need for studies that include these parameters.

Conclusion

This multicenter retrospective study demonstrated that short-term postoperative complication rates were similar across age groups, including patients aged ≥80 years, despite their higher-risk profiles. However, elderly patients were less likely to undergo advanced imaging or receive neoadjuvant treatment. These findings support the need for age-appropriate, multidisciplinary preoperative evaluation, including comprehensive geriatric assessment, to ensure

optimal care. Further research is warranted to assess long-term outcomes and adjust for potential confounders. Prospective studies examining comprehensive geriatric assessment data and investigating long-term oncologic outcomes are essential for generating robust evidence on this topic.

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*Turkish CRC Database Study Group: Özgen Işık, Prof. MD. (Acıbadem Mehmet Ali Aydınlar University Faculty of Medicine Department of General Surgery; Acıbadem

Atakent Hospital, İstanbul, Türkiye); Çiğdem Benlice, MD. (Acıbadem Altunizade Hospital, Clinic of General Surgery, İstanbul, Türkiye); Tayfun Bişgin, Assoc. Prof. MD. (Dokuz Eylül University Faculty of Medicine, Department of General Surgery, İzmir, Türkiye); Osman Bozbıyık, Assoc. Prof. MD. (Ege University Faculty of Medicine, Department of General Surgery, İzmir, Türkiye); Semra Demirli Atıcı, MD. (Acıbadem İzmir Kent Hospital, Clinic of General Surgery, İzmir, Türkiye) Mehmet Ali Koç, Assoc. Prof. MD. (Ankara University Faculty of Medicine, Department of General Surgery, Ankara, Türkiye); Cemil Burak Kulle, Asst. Prof. (İstanbul University, İstanbul Faculty of Medicine,Department of General Surgery, İstanbul, Türkiye); Nuri Okkabaz, Prof. MD. (Atlas University Faculty of Medicine, Department of General Surgery, İstanbul, Türkiye); MD. Volkan Özben, Prof. MD. (Acıbadem Mehmet Ali Aydınlar University Faculty of Medicine, Department of General Surgery, İstanbul, Türkiye); Ahmet Rencüzoğulları, Prof. MD. (Koç University Faculty of Medicine, Department of General Surgery, İstanbul, Türkiye); İsmail Tırnova, Asst. Prof. (Başkent University Faculty of Medicine, Department of General Surgery, İstanbul, Türkiye); Uğur Topal, Asst. Prof. (Çukurova University Faculty of Medicine, Department of General Surgery, Adana, Türkiye)

Ethics

Ethics Committee Approval: Ethical approval was obtained from the ethics committee of Republic of Türkiye Bursa Uludağ University Health Research Ethics Committee (decision no.: 2025/579-7/12, dated: 19.03.2025).

Informed Consent: The principles of the Helsinki Declaration were followed, and informed consent was waived due to the retrospective design.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.A.A., E.G., Ö.I., T.Y., Concept: E.G., Ö.I., T.Y., Design: A.A.A., E.G., Ö.I., T.Y., Data Collection or Processing: E.G., Analysis or Interpretation: E.G., Ö.I., Literature Search: A.A.A., E.G., Writing: A.A.A., E.G., Ö.I.

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REFERENCES

1. Chong RC, Ong MW, Tan KY. Managing elderly with colorectal cancer. J Gastrointest Oncol. 2019;10:1266-1273.
2. No authors listed. Surgery for colorectal cancer in elderly patients: a systematic review. Colorectal Cancer Collaborative Group. Lancet. 2000;356:968-974.
3. Park H, Parys S, Tan J, Entriken F, Hodder R. Post-operative outcomes in the elderly following colorectal cancer surgery. ANZ J Surg. 2021;91:387-391.
4. Weerink LBM, Gant CM, van Leeuwen BL, de Bock GH, Kouwenhoven EA, Faneyte IF. Long-term survival in octogenarians after surgical treatment for colorectal cancer: prevention of postoperative complications is key. Ann Surg Oncol. 2018;25:3874-3882.
5. Pirrera B, Vaccari S, Cuicchi D, Lecce F, De Raffele E, Via BD, Di Laudo M, Tonini V, Cervellera M, Cola B. Impact of octogenarians on surgical outcome in colorectal cancer. Int J Surg. 2016;35:28-33.
6. Ming-Gao G, Jian-Zhong D, Yu W, You-Ben F, Xin-Yu H. Colorectal cancer treatment in octogenarians: elective or emergency surgery? World J Surg Oncol. 2014;12:386.
7. Kvasnovsky CL, Adams K, Sideris M, Laycock J, Haji AK, Haq A, Nunoo-Mensah J, Papagrigoriadis S. Elderly patients have more infectious complications following laparoscopic colorectal cancer surgery. Colorectal Dis. 2016;18:94-100.
8. Mäkelä JT, Kiviniemi H. Surgical treatment of colorectal cancer in patients aged over 80 years. Int J Colorectal Dis. 2012;27:1055-1060.
9. Ogata T, Yoshida N, Sadakari Y, Iwanaga A, Nakane H, Okawara K, Endo K, Kaneshiro K, Hirokata G, Aoyagi T, Shima H, Taniguchi M. Colorectal cancer surgery in elderly patients 80 years and older: a comparison with younger age groups. J Gastrointest Oncol. 2022;13:137-148.
10. van der Sijp MP, Bastiaannet E, Mesker WE, van der Geest LG, Breugom AJ, Steup WH, Marinelli AW, Tseng LN, Tollenaar RA, van de Velde CJ, Dekker JW. Differences between colon and rectal cancer in complications, short-term survival and recurrences. Int J Colorectal Dis. 2016;31:1683-1691.
11. Teo NZ, Ngu JCY. Robotic surgery in elderly patients with colorectal cancer: Review of the current literature. World J Gastrointest Surg. 2023;15:1040-1047.
12. ten Broek RP, Issa Y, van Santbrink EJ, Bouvy ND, Kruitwagen RF, Jeekel J, Bakkum EA, Rovers MM, van Goor H. Burden of adhesions in abdominal and pelvic surgery: systematic review and met-analysis. BMJ. 2013;347:f5588.

13. Weiss JM, Pfau PR, O'Connor ES, King J, LoConte N, Kennedy G, Smith MA. Mortality by stage for right- versus left-sided colon cancer: analysis of surveillance, epidemiology, and end results--medicare data. J Clin Oncol. 2011;29:4401-4409.
14. Shinji S, Yamada T, Matsuda A, Sonoda H, Ohta R, Iwai T, Takeda K, Yonaga K, Masuda Y, Yoshida H. Recent advances in the treatment of colorectal cancer: a review. J Nippon Med Sch. 2022;89:246-254.
15. Ahmed S, Howel D, Debrah S; NORCCAG (Northern Region Colorectal Cancer Audit Group). The influence of age on the outcome of treatment of elderly patients with colorectal cancer. J Geriatr Oncol. 2014;5:133-140.
16. Lim SW, Kim YJ, Kim HR. Laparoscopic surgery for colorectal cancer in patients over 80 years of age: the morbidity outcomes. Ann Surg Treat Res. 2017;92:423-428.
17. Luo W, Wu M, Chen Y. Laparoscopic versus open surgery for elderly patients with colorectal cancer: a systematic review and meta-analysis of matched studies. ANZ J Surg. 2022;92:2003-2017.
18. Devoto L, Celentano V, Cohen R, Khan J, Chand M. Colorectal cancer surgery in the very elderly patient: a systematic review of laparoscopic versus open colorectal resection. Int J Colorectal Dis. 2017;32:1237-1242.
19. Fujii S, Tsukamoto M, Fukushima Y, Shimada R, Okamoto K, Tsuchiya T, Nozawa K, Matsuda K, Hashiguchi Y. Systematic review of laparoscopic vs open surgery for colorectal cancer in elderly patients. World J Gastrointest Oncol. 2016;8:573-582.
20. Osseis M, Nehmeh WA, Rassy N, Derienne J, Noun R, Salloum C, Rassy E, Boussios S, Azoulay D. Surgery for T4 colorectal cancer in older patients: determinants of outcomes. J Pers Med. 2022;12:1534.
21. Seishima R, Okabayashi K, Hasegawa H, Tsuruta M, Shigeta K, Matsui S, Yamada T, Kitagawa Y. Is laparoscopic colorectal surgery beneficial for elderly patients? A systematic review and meta-analysis. J Gastrointest Surg. 2015;19:756-765.
22. Peltrini R, Imperatore N, Carannante F, Cuccurullo D, Capolupo GT, Bracale U, Caricato M, Corcione F. Age and comorbidities do not affect short-term outcomes after laparoscopic rectal cancer resection in elderly patients. A multi-institutional cohort study in 287 patients. Updates Surg. 2021;73:527-537.
23. Papamichael D, Audisio RA, Glimelius B, de Gramont A, Glynne-Jones R, Haller D, Köhne CH, Rostoft S, Lemmens V, Mitry E, Rutten H, Sargent D, Sastre J, Seymour M, Starling N, Van Cutsem E, Aapro M. Treatment of colorectal cancer in older patients: International Society of Geriatric Oncology (SIOG) consensus recommendations 2013. Ann Oncol. 2015;26:463-476.
24. Zawadzki M, Krzystek-Korpacka M, Rząca M, Czarnecki R, Obuszko Z, Witkiewicz W. Colorectal surgery in elderly population. Pol Przegl Chir. 2018;90:29-34.
25. Ngu JC, Kuo LJ, Teo NZ. Minimally invasive surgery in the geriatric patient with colon cancer. J Gastrointest Oncol. 2020;11:540-544.
26. Lee S, Surabhi VR, Kassam Z, Chang KJ, Kaur H. Imaging of colon and rectal cancer. Curr Probl Cancer. 2023;47:100970.
27. Lorenzo Liñán MÁ, García Armengol J, Martín Martín GP, Martínez Sanjuán V, Roig Vila JV. Validation of pelvic magnetic resonance imaging as the method of choice to determine the distance to the anal margin in rectal cancer. Cir Esp (Engl Ed). 2022;100:772-779.
28. Georgiou PA, Tekkis PP, Constantinides VA, Patel U, Goldin RD, Darzi AW, John Nicholls R, Brown G. Diagnostic accuracy and value of magnetic resonance imaging (MRI) in planning exenterative pelvic surgery for advanced colorectal cancer. Eur J Cancer. 2013;49:72-81.
29. Fahmawi Y, Smith C, Grimm L, Khullar S, Rider P, Hunter J, Iliff G, Mneimneh W, Roveda K, Wang B, Prodduturvar P, Alkharabsheh O, McCormick B, Mizrahi M, Khushman M. Usefulness of restaging pelvis magnetic resonance ımaging after neoadjuvant concurrent chemoradiotherapy in patients with locally advanced rectal cancer. Clin Colorectal Cancer. 2020;19:e281-e287.
30. Santos MD, Silva C, Rocha A, Matos E, Nogueira C, Lopes C. Prognostic value of mandard and dworak tumor regression grading in rectal cancer: study of a single tertiary center. ISRN Surg. 2014;2014:310542.
31. Rosati G, Lonardi S, Galli F, Di Bartolomeo M, Ronzoni M, Zampino MG, Banzi M, Zaniboni A, Pasini F, Bozzarelli S, Garattini SK, Ferrari D, Montesarchio V, Mambrini A, Ciuffreda L, Galli F, Pusceddu V, Carlomagno C, Bidoli P, Amoroso D, Bochicchio AM, Frassineti L, Corsi D, Bilancia D, Pastorino A, De Stefano A, Labianca R; TOSCA (Three or Six Colon Adjuvant) investigators. Oxaliplatin plus fluoropyrimidines as adjuvant therapy for colon cancer in older patients: a subgroup analysis from the TOSCA trial. Eur J Cancer. 2021;148:190-201.
32. Hamed RA, Korpanty G, Kelly D. Toxicities and outcomes of neoadjuvant treatment in elderly patients with locally advanced rectal cancer: a scoping review protocol. BMJ Open. 2022;12:e061397.
33. Li Y, Wang J, Ma X, Tan L, Yan Y, Xue C, Hui B, Liu R, Ma H, Ren J. A review of neoadjuvant chemoradiotherapy for locally advanced rectal cancer. Int J Biol Sci. 2016;12:1022-1031.
34. Cheong CK, Nistala KRY, Ng CH, Syn N, Chang HSY, Sundar R, Yang SY, Chong CS. Neoadjuvant therapy in locally advanced colon cancer: a meta-analysis and systematic review. J Gastrointest Oncol. 2020;11:847-857.
35. Petrelli F, Trevisan F, Cabiddu M, Sgroi G, Bruschieri L, Rausa E, Ghidini M, Turati L. Total neoadjuvant therapy in rectal cancer: a systematic review and meta-analysis of treatment outcomes. Ann Surg. 2020;271:440-448.

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RESEARCH ARTICLE

Efficacy and Safety of Crystallized Phenol in the Treatment of Pilonidal Sinus Disease
Crystallized Phenol for Pilonidal Sinus Disease

Burak Kutlu[1], Çiğdem Benlice[2]

[1]Acıbadem Ankara Hospital, Clinic of General Surgery, Ankara, Türkiye
[2]Acıbadem Altunizade Hospital, Clinic of General Surgery, İstanbul, Türkiye

ABSTRACT

Aim: Pilonidal sinus is a common condition in general surgery practice, with various treatment options available. Treatment effectiveness varies based on individual patient characteristics, and recurrence rates of up to 30% have been reported. Crystallized phenol has gained attention as a minimally invasive method due to its low morbidity and enhanced patient comfort. This study aimed to examine the clinical effectiveness of crystallized phenol and factors influencing recurrence.

Method: This retrospective cohort study included 82 patients aged 18 years and older treated between September 2022 and September 2024. Data on age, body mass index (BMI), gender, sinus number, hospital stay, return to normal activities, follow-up duration, and complications were collected. Patients were followed up at 1 and 30 days post-procedure and for an average of 2 years. Recurrence rates were recorded through clinic examination.

Results: Eighty-two patients (54 men) were included in the study. The mean age was 25.9±8.1 years, and the mean BMI was 28.7±3.9, with 17.6% of patients classified as obese. Crystallized phenol was applied under spinal anesthesia in 63 cases (76.8%). At the end of the follow-up period, a 10% recurrence rate was observed.

Conclusion: Crystallized phenol is a minimally invasive, low-complication treatment that enables a quick return to daily life. High BMI and sinus pit number were identified as significant factors for recurrence. Similar recurrence rates were observed across centers, highlighting the consistency of the method. Further prospective randomized controlled trials are needed to confirm these findings.

Keywords: Crystallized phenol, pilonidal sinus, recurrence

Introduction

Pilonidal sinus disease (PSD) is an acquired condition of the sacrococcygeal region, where hair-containing debris penetrates the natal cleft, causing chronic inflammation and recurrent infection. Despite its benign nature, PSD imposes a substantial healthcare burden, with an annual incidence of 26-100 per 100,000 and a rising global trend.[1,2] It predominantly affects young men, with peak incidence in the early 20s and a male-to-female ratio of at least 2:1.[3] Risk factors include family history, hirsutism, obesity, and prolonged sitting.[4]

The accepted pathophysiology involves hair shafts acting as foreign bodies, triggering a granulomatous reaction, follicular obstruction, and sinus formation.[5,6] Clinically, PSD ranges from asymptomatic pits to painful abscesses and chronic draining sinuses, leading to work or school absenteeism and impaired quality of life. Although hygiene and depilation are essential, surgery remains the primary treatment. Traditional excision techniques offer low recurrence but carry risks of wound complications and prolonged healing. Off-midline flaps (e.g., Limberg, Karydakis) reduce wound morbidity but lack clear

Address for Correspondence: Burak Kutlu MD, Acıbadem Ankara Hospital, Clinic of General Surgery, Ankara, Türkiye
E-mail: mdburakkutlu@gmail.com **ORCID ID:** orcid.org/0000-0001-8392-0504
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superiority across all outcomes. Minimally invasive methods -including phenol injection, unroofing, and video-assisted and endoscopic approaches- aim to balance efficacy with faster recovery and lower morbidity.[7]

Phenol, a low-cost sclerosing agent with antiseptic and anesthetic properties, can be applied in outpatient settings. Crystallized phenol yields single-session success rates of 60%-70% and >90% with multiple sessions, although recurrence remains variable.[8] As recurrence is a key concern, evaluating phenol therapy across diverse populations may help identify clinical or contextual predictors of treatment failure.

This multicenter study evaluates crystallized phenol therapy by assessing (i) recurrence rates, (ii) complication profiles, and (iii) clinical and sociodemographic predictors of recurrence.

Materials and Methods

Study Design and Setting

This retrospective multicenter cohort study analyzed the medical records of patients who underwent crystallized phenol therapy for PSD between September 2022 and September 2024. Patients were identified using the International Classification of Diseases, 10th revision, codes L05.0 and L05.9 (pilonidal cyst and sinus with/without abscess) using clinical portal databases.

Data were collected from two institutions with a shared surgical approach and identical treatment protocols: two private hospitals in Ankara and İstanbul, serving a predominantly urban population with high socioeconomic status.

Patient Selection

Eligible participants were adults diagnosed with primary PSD who had no prior surgical excision, flap reconstruction, or endoscopic intervention. Patients were excluded if, during admission, they exhibited signs of active infection (e.g., abscess or cellulitis), were receiving immunosuppressive therapy or had a diagnosis of diabetes mellitus, possessed incomplete medical records, or were lost to follow-up (defined as missing one or more scheduled visits), as shown in the patient selection diagram in Figure 1.

All procedures were performed following a standardized protocol by two general surgeons, each with over 5 years of independent surgical practice and specific experience in managing PSD. Both surgeons had received training in crystallized phenol application in the same university hospital. The application technique, patient positioning, and post-procedure care protocols were standardized and consistently applied across both centers to minimize interoperator variability.

Surgical Procedure

Patients were placed in the prone position, and the gluteal cleft was shaved and disinfected with an antiseptic solution.

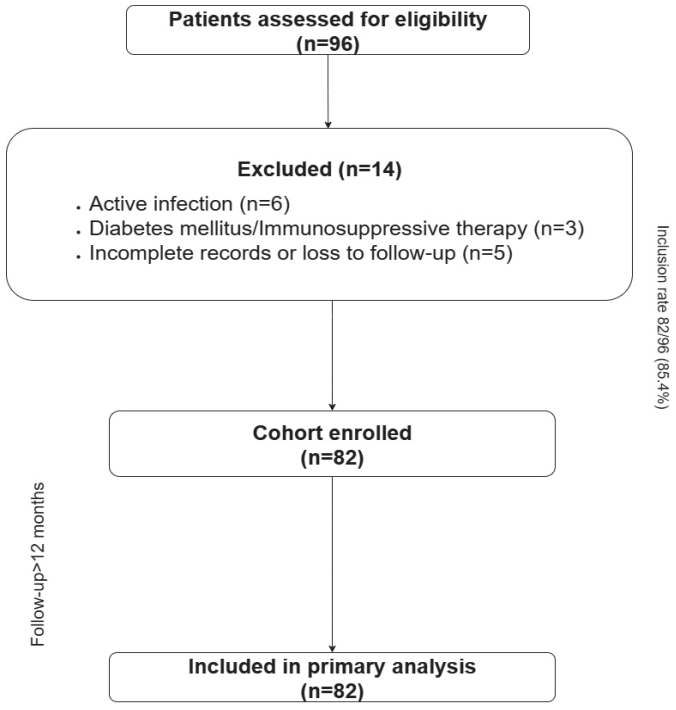

Figure 1. Patient flow diagram

If the procedure was performed in an office setting, local anesthesia (2% lidocaine with epinephrine) was administered, whereas in the operating room, it was performed under general/spinal anesthesia. The sinus tract was cleaned and thoroughly irrigated with 0.9% saline. Crystallized phenol was applied directly into the sinus tract. Treatment sessions were repeated at 3-week intervals if necessary, up to a maximum of two sessions per patient. Post-procedure care included guidance on wound hygiene, daily showering, avoidance of tight clothing, and minimizing prolonged sitting.

Crystallized phenol (pure solid form) was used in all procedures. Approximately 3-5 g of phenol was applied per session depending on the size and number of sinus tracts.[9] Phenol crystals were gently placed into the tract using a blunt-tipped applicator under direct visualization, ensuring complete filling without exerting excessive pressure. In cases with multiple pits, the same total dose was distributed proportionally. Prior to application, the surrounding skin was protected with ointment to avoid chemical burns. All procedures were performed with gloves and goggles to prevent phenol exposure. No dose-response analysis was performed regarding recurrence or complications.

All patients underwent clinical examination on postoperative day 1 and at the end of the first month. Long-term follow-up was conducted at 12 months post-treatment, either through in-person visits. For the purposes of this study, only the first documented recurrence per patient was recorded and included in the analysis.

The following variables were systematically extracted from medical records: age, sex, body mass index (BMI), smoking status, disease duration, number of sinus pits, presence of abscess, operation time, anesthesia technique, and follow-up duration. Early postoperative infection, skin necrosis, and phenol-related chemical burns are accepted as surgical complications. Development of a new sinus tract or abscess in the same anatomical region following documented healing is confirmed as recurrence clinically. Complete epithelialization within 3 months of the initial treatment session is accepted healing.

Statistical Analysis

All analyses were performed using SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed using the Shapiro-Wilk test, with the results presented as mean ± standard deviation (SD). Group comparisons employed Student's t-test or the Mann-Whitney U test for continuous data and the chi-square (χ^2) test or Fisher's exact test for categorical variables. Independent predictors of recurrence were identified using stepwise logistic regression analysis (significance level: $p<0.05$).

This study was approved by the institutional review board of Acıbadem Mehmet Ali Aydınlar University Medical Research Ethics Committee (ATADEK) (approval number: 2025-09/77, dated: 12.06.2025). All procedures were conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients prior to treatment initiation.

Results

A total of 96 patients were screened for eligibility. Fourteen patients were excluded, six due to active infection, three due to diabetes mellitus or ongoing immunosuppressive therapy, and five due to incomplete medical records or loss to follow-up. Ultimately, 82 patients met the inclusion criteria and were included in the final analysis. A flowchart summarizing the screening and inclusion process is presented in Figure 1.

Between September 2022 and September 2024, crystallized phenol ablation was applied to 82 consecutive patients with primary PSD across two centers. The cohort was 65.9% men (n=54) and 34.1% (n=28) women, with an overall median age of 25.8 years. The mean ± SD) height, weight, and BMI were 177±7 cm, 85.4±12.6 kg, and 28.7±3.9 kg/m^2, respectively; 17.6% (n=14) of patients met the criterion for obesity (BMI >30 kg/m^2). A single sinus pit was identified in 60 patients, whereas 16, 4, and 2 patients presented with two, three, and four pits, respectively, indicating a moderate spectrum of anatomical complexity. Of the 82 patients, 56 (68.3%) were current smokers, whereas 26 (31.7%) had never smoked. Recurrence was documented in five smokers (8.9%) and in three non-smokers (11.5%). Fisher's exact test showed no significant association between smoking status and treatment failure (p=0.70), indicating that cigarette use was not an independent determinant of recurrence in this cohort (Table 1).

All patients presented with pain. Beyond this ubiquitous symptom, 13 individuals (15.9%) reported active discharge from the sinus tract, and 6 (7.3%) had previously undergone abscess drainage. Only 15 patients (18.3%) were evaluated at the time of their initial diagnosis; the remaining 67 (81.7%) had experienced symptoms for 8±1 months (mean ± SD, as shown in Table 1) prior to crystallized phenol treatment.

Median follow-up was 24 months (interquartile range: 22-25), during which recurrence was systematically assessed in all patients (n=82). Recurrence was defined as the appearance of a new sinus tract or abscess in the same anatomical region following complete healing. Overall, eight recurrences (10%) were documented. Among the eight patients who experienced recurrence, three (37.5%) were classified as early recurrences (<6 months) and five (62.5%) as late recurrences (>6 months). All eight recurrences were detected during clinical evaluations. No multiple recurrences were observed during the study period.

Recurrence was observed in 3 of the 28 female patients (10.7%) and in 5 of the 54 male patients (9.3%). Fisher's exact test demonstrated no significant association between sex and recurrence (p =0.92). Recurrence risk varied markedly across BMI; no failures were recorded in the underweight group (n=12, BMI ≤18.5 kg/m^2), whereas 3 of the 56 patients with BMI 18.6-29.9 kg/m^2 relapsed (5.4%). By contrast, 5 of the 14 patients with obesity (35.7%) experienced recurrence.

Table 1. Demographic characteristics of patients (n=82)

Sex (n, %)	
Male	54 (65.9%)
Female	28 (34.1%)
Age, years (mean ± SD)	25.9±8.1
Height, cm (mean ± SD)	177±7
Weight, kg (mean ± SD)	85.4±12.6
Body mass index, kg/m^2 (mean ± SD)	28.7±3.9
Pit number (n, %)	1 (n=60, 73.1%) 2 (n=16, 19.5%) 3 (n=4, 4.8%) 4 (n=2, 2.4%)
Smoking status (n, %)	
Smoker	56 (68.3%)
Non-smoker	26 (31.7%)
Disease duration, months (mean ± SD)	8±1

SD: Standard deviation

The χ^2 test confirmed a significant association between BMI and recurrence (p=0.0013). When the data were dichotomized, obesity conferred a 12-fold increase in risk: 35.7% versus 4.4% for patients without obesity [odds ratio (OR) = 12.0, 95% confidence interval (CI): 2.45-59.15; p=0.003]. Overall analysis identified obesity as a significant predictor of recurrence following crystallized phenol ablation in PDS. Six of the eight patients experiencing recurrence had presented initially with more than one sinus opening, whereas only two recurrences arose in individuals with a solitary tract (p<0.05). All recurrences were managed successfully by excisional surgery without further sequelae.

Logistic regression was performed with recurrence as the dependent variable and the three covariates that showed either clinical relevance or a univariable signal: obesity, anatomical complexity, and sex. Following adjustment, obesity remained a strong independent predictor of failure, conferring an almost 12-fold increase in risk (OR =12.0, 95% CI: 2.45-59.15; p=0.003). Likewise, the presence of multiple pits independently elevated the likelihood of recurrence more than seven-fold (OR =7.4, 95% CI: 1.6-34.0; p=0.011). By contrast, sex had no significant effect (OR =1.1, 95% CI: 0.2-3.9; p =0.92). These findings indicate that elevated BMI and greater anatomical complexity are the principal determinants of treatment failure following crystallized phenol ablation, whereas patient sex does not appear to influence outcome in this population group (Table 2).

Spinal anesthesia was chosen in 63 cases (76.8%), local anesthesia in 14 (17.1%), general anesthesia in 4 (4.9%), and intravenous sedation in 1 (1.2%). All same-day discharges occurred in patients treated under local infiltration anesthesia (n=14) or intravenous sedation (n=1). By contrast, every patient who received spinal (n=63) or general anesthesia (n=4) was observed in hospital for 1 night before discharge. Mean operative time for the whole cohort was 38.8±10.9 minutes (n=82). When stratified by anesthetic technique, procedures performed under spinal anesthesia (n=63) lasted 42.6±9.5 minutes, whereas those performed with local infiltration, general anesthesia, or intravenous sedation (n=19) averaged 26.3±2.1 minutes. This indicates that spinal anesthesia prolongs

Table 2. Univariable and multivariable analysis of factors associated with recurrence following crystallized phenol ablation for pilonidal disease

Variable	Recurrence/total (%)	Univariable analysis			Multivariable analysis*		
		OR	95% CI	p-value	OR	95% CI	p-value
Sex	—	—	—	0.92	—	—	—
Male	5/54 (9.3%)	—	—	—	—	—	—
Female	3/28 (10.7%)	1.2	0.3-4.8	—	1.1	0.2-3.9	0.92
BMI category	—	—	—	0.0013	—	—	—
Underweight (≤18.5 kg/m^2)	0/12 (0%)	—	—	—	—	—	—
Normal/overweight (18.6-29.9 kg/m^2)	3/56 (5.4%)	—	—	—	—	—	—
Obese (≥30 kg/m^2)	5/14 (35.7%)	9.8	2.0-48.0	—	—	—	—
BMI (Dichotomized)	—	—	—	0.003	—	—	—
Non-obese (<30 kg/m^2)	3/68 (4.4%)	—	—	—	—	—	—
Obese (≥30 kg/m^2)	5/14 (35.7%)	12.0	2.45-59.15	—	12.0	2.45-59.15	0.003
Anatomical complexity	—	—	—	<0.05	—	—	—
Single pit	2/60 (3.3%)		—	—		—	—
Multiple pits	6/22 (27.2%)	—	—	—	7.4	1.6-34.0	0.011

OR: Odds ratio, CI: Confidence interval, BMI: Body mass index

Note: Fisher's exact test was used for sex comparison; the chi-square test was used for BMI categories.

*Binary logistic regression with recurrence as the dependent variable. Reported ORs are adjusted; 95% confidence intervals and two-sided p-values are provided. Reference categories: BMI<30 kg/m^2, single pit, female.

Table 3. Anesthesia technique distribution, operation time, and hospital stay

Operative time, minutes (mean ± SD)	38.8±10.9	p-value
Spinal anesthesia (n = 63)	42.6±9.5	
Local/sedation/general anesthesia (n = 19)	26.3±2.1	p<0.001
Anesthesia technique (n, %)	Spinal (n=63, 76.8%) Local (n=14, 17.1%) General (n=4, 4.9%) Sedation (n=1, 1.2%)	
Hospital stay (n, %)		
Same day discharge	15 (18.2%)	
Overnight stay (1 night)	67 (81.7%)	

SD: Standard deviation

operative time by roughly one-third, an effect attributable to additional regional-block set-up and patient positioning requirements (p<0.001) (Table 3). No perioperative or early postoperative complications, reinterventions, or unplanned readmissions were recorded.

Discussion

This study contributes to the growing body of evidence supporting the use of crystallized phenol as a minimally invasive and cost-effective treatment option for PSD, particularly in appropriately selected patients. By evaluating a large, well-documented cohort with uniform technique application in two distinct clinical settings, we aimed to assess both the efficacy and safety of this approach. Our findings demonstrate a low short-term recurrence rate and minimal complication profile, reinforcing the viability of crystallized phenol as an outpatient procedure. Recurrence may be influenced not only by anatomical or technical factors but also by contextual variables such as hygiene practices and education levels. These observations underline the importance of individualized treatment planning and highlight the potential value of phenol therapy in low-resource settings or among patients seeking nonsurgical management.

Crystallized phenol application for PSD has been widely utilized in outpatient settings under local anesthesia. Reported complication rates remain low (typically under 15%), with most adverse events limited to minor infections or localized skin irritation. Clinical resolution rates range between 67% and 100%, with recurrence rates reported to be below 20% when the procedure is correctly applied. These outcomes are consistent with the recommendations of the American Society of Colon and Rectal Surgeons, which supports the use of phenol therapy as a minimally invasive alternative with high efficacy and low morbidity when executed using proper techniques. The favorable safety profile and cost-effectiveness of phenol treatment make it an attractive first-line option, particularly in settings where surgical resources are limited or patient preference favors non-excisional management.[10]

Recent evidence supports the efficacy of phenol-based treatments across different patient populations. A prospective cohort study utilizing phenol solution reported an overall recurrence rate of 8.3% at 2-year follow-up, with sinus tract volume and sinus number identified as significant predictors of recurrence.[11] Consistent with these findings, the present study also observed a higher recurrence rate among patients with multiple sinus openings, suggesting that disease extent may play a critical role in long-term outcomes following crystallized phenol application. This reinforces the importance of careful pre-procedural assessment and may inform patient selection criteria for optimizing treatment success.

The temporal pattern of recurrence underscores the importance of extended follow-up in pilonidal disease research. Meta-analyses have demonstrated that recurrence rates can increase dramatically over time: primary midline closure shows recurrence rates of 7% at 24 months, 16.8% at 60 months, and 67.9% at 240 months. By contrast, advancement and rotational flaps demonstrate more stable long-term outcomes, with recurrence rates increasing modestly from 0.2% to 1.9% and 0.4% to 5.2% at 12 and 60 months, respectively. Notably, phenol therapy shows an intermediate pattern, with recurrence rates rising from 1.9% at 12 months to approximately 40% at 60 months, emphasizing the need for long-term surveillance.[12] Future clinical trials should be designed with longer-term follow-up for a more reliable conclusion to be drawn. Although these methods were not part of our treatment protocol, understanding their long-term recurrence trajectories helps contextualize the necessary duration of follow-up in minimally invasive pilonidal sinus interventions, including crystallized phenol application.

Compared with traditional excisional techniques, crystallized phenol therapy offers distinct advantages in terms of recovery time, morbidity, and cost. Patients who require surgery for

PSD may undergo excision and primary repair, excision with healing by secondary intention, or excision with marsupialization, based on surgeon and patient preference. For patients requiring more extensive surgical intervention, several established techniques demonstrate favorable outcomes. The Limberg rhomboid flap, which excises all sinuses to the presacral fascia while flattening the gluteal cleft, has shown excellent long-term results, with recurrence rates of 0%-6%.[13] In a randomized controlled study, the Karydakis procedure achieved a 6% recurrence rate, 20% wound morbidity, and 98% overall healing rate at a follow-up of 3 years.[14] Karydakis's personal series of over 6,000 patients demonstrated recurrence rates of less than 2%, with wound complications in 8%.[15]

When compared directly with excision and primary closure, phenol application has shown nonsignificantly lower recurrence rates, suggesting comparable efficacy with reduced morbidity. The appeal of phenol therapy lies in its ability to avoid the complications associated with more extensive surgical interventions. Although local anesthesia could be considered the preferred approach for most patients undergoing this minimally invasive treatment, traditional surgical approaches require general anesthesia, extensive healthcare costs, and prolonged hospitalization and are frequently associated with wound complications and unsatisfactory cosmetic outcomes. By contrast, phenol application can be performed in an outpatient setting with minimal anesthesia requirements and reduced recovery time. The use of phenol solution involves one or more injections into the sinus tract until filled, with cautious protection of the surrounding normal skin, removal of sinus hairs and debris with forceps, as well as local shaving. Small case series have demonstrated success rates ranging from 60% to 95%. Even in the setting of recurrent chronic sinus disease, phenol injection and local depilatory cream application on a weekly basis have shown low subsequent recurrence rates (0%-11%) at extended follow-up.[16,17]

Emerging minimally invasive techniques offer promising alternatives to traditional excisional surgery. Endoscopic pilonidal sinus treatment is performed under direct vision, allowing for the removal of all infected tissues and the lining of the sinus cavity.[18] However, endoscopic techniques require specialized equipment and expertise, limiting their widespread adoption. Recent reviews report failure rates of 8.04%. Complications including hematoma, infection, persistent discharge, and failure of healing across the study ranged from 0% to 11.1%. The mean return to work and normal activities was remarkably short at 2.9±1.8 days.[19] Although there are other minimally invasive techniques that involve curettage of the pilonidal sinus with local injection of fibrin glue or phenol, such techniques are performed in a blind manner without allowing the interior of the sinus cavity to be visualized, which may lead to incomplete debridement and cleaning of hairs and infected tissues inside the sinus.

Laser treatment has become popular in recent years, with both laser and crystallized phenol applications emerging as effective minimally invasive alternatives in the management of PSD, offering favorable outcomes in terms of recurrence rates, complication profiles, and patient satisfaction. Crystallized phenol provides the distinct advantage of being an outpatient procedure, enabling early return to daily activities with minimal postoperative care. By contrast, laser therapy is typically associated with fewer treatment sessions and a shorter overall recovery period. The choice between these modalities should be guided by patient preferences, clinical presentation, and the availability of institutional resources. As interest in less invasive strategies continues to grow, both laser and phenol-based approaches have garnered increasing attention in the recent literature, underscoring the need for prospective, comparative studies to better define their respective roles and long-term efficacy.[20]

A comprehensive analysis by Kumar et al.[21] of 983 studies spanning 8 decades revealed significant gaps in the pilonidal disease literature. Notably, only 12% of identified primary research articles were randomized controlled trials, indicating a heavy reliance on observational studies. This mapping review confirmed the absence of clearly superior surgical interventions for PSD, highlighting the need for high-quality comparative studies.

Our findings support the continued use of crystallized phenol therapy as a first-line treatment for PSD, particularly in patients seeking minimal invasive intervention with rapid recovery. The technique's cost-effectiveness and outpatient applicability make it especially valuable in resource-limited settings. However, patients should be counseled regarding the potential need for repeat treatments and long-term surveillance for recurrence. Healthcare providers should consider environmental, occupational, and lifestyle factors when selecting treatment modalities and planning follow-up care. This personalized approach may optimize treatment success and reduce long-term recurrence rates.

Several limitations warrant consideration when interpreting our findings. The retrospective design may have introduced selection bias and limited the detection of rare adverse events, and the relatively short follow-up period may have led to long-term recurrence rates being underestimated. Future research should prioritize long-term prospective studies with 5-10-year follow-up periods to establish definitive recurrence patterns. Additionally, patient-reported outcome measures and quality-of-life assessments were not systematically collected, limiting our understanding of treatment impact from the patient perspective. Standardized outcome measures, including

patient-reported outcomes and quality-of-life indices, should be incorporated into study protocols. Lastly, the study population was drawn exclusively from two urban private hospitals, potentially limiting the generalizability of our findings to rural settings or public healthcare institutions with differing patient profiles and healthcare access.

Conclusion

Crystallized phenol therapy represents an effective, minimally invasive treatment option for PSD with acceptable recurrence rates and minimal morbidity. Although long-term recurrence remains a concern, the technique's advantages in terms of patient comfort, cost-effectiveness, and outpatient applicability support its continued use in appropriate patients. In our case series, obesity and the presence of multiple sinus openings independently predicted recurrence following crystallized phenol therapy. This is consistent with previous reports demonstrating that elevated BMI may impair wound healing and contribute to higher recurrence rates, whereas greater anatomical complexity increases the likelihood of residual tracts following minimally invasive interventions. Future research should focus on identifying optimal patient selection criteria and developing strategies to minimize long-term recurrence while maintaining the technique's inherent advantages.

Ethics

Ethics Committee Approval: This study was approved by the institutional review board of Acıbadem Mehmet Ali Aydınlar University Medical Research Ethics Committee (ATADEK) (approval number: 2025-09/77, dated: 12.06.2025).

Informed Consent: Written informed consent was obtained from all patients prior to treatment initiation.

Footnotes

Authorship Contributions

Surgical and Medical Practices: B.K., Ç.B., Concept: B.K., Ç.B., Design: B.K., Ç.B., Data Collection or Processing: B.K., Ç.B., Analysis or Interpretation: B.K., Ç.B., Literature Search: B.K., Ç.B., Writing: B.K., Ç.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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References

1. Oetzmann von Sochaczewski C, Gödeke J. Pilonidal sinus disease on the rise: a one-third incidence increase in inpatients in 13 years with substantial regional variation in Germany. Int J Colorectal Dis. 2021;36:2135-2145.
2. Søndenaa K, Andersen E, Nesvik I, Søreide JA. Patient characteristics and symptoms in chronic pilonidal sinus disease. Int J Colorectal Dis. 1995;10:39-42.
3. Luedi MM, Schober P, Stauffer VK, Diekmann M, Doll D. Global gender differences in pilonidal sinus disease: a random-effects meta-analysis. World J Surg. 2020;44:3702-3709.
4. Doll D, Matevossian E, Wietelmann K, Evers T, Kriner M, Petersen S. Family history of pilonidal sinus predisposes to earlier onset of disease and a 50% long-term recurrence rate. Dis Colon Rectum. 2009;52:1610-1615.
5. Bendewald FP, Cima RR. Pilonidal disease. Clin Colon Rectal Surg. 2007;20:86-95.
6. da Silva JH. Pilonidal cyst: cause and treatment. Dis Colon Rectum. 2000;43:1146-1156.
7. Boulanger G, Abet E, Brau-Weber AG, Leclair F, Denimal F, Jean MH, de Kerviler B, Comy M. Is histological analysis of pilonidal sinus useful? Retrospective analysis of 731 resections. J Visc Surg. 2018;155:191-194.
8. Kayaalp C, Aydin C. Review of phenol treatment in sacrococcygeal pilonidal disease. Tech Coloproctol. 2009;13:189-193.
9. Kutluer N, Doğan S, Öndeş B, Kurt F. Comparison of surgical treatment with crystallized phenol treatment in recurrent pilonidal sinuses. Turk J Colorectal Dis. 2022;32:117-122.
10. Johnson EK, Vogel JD, Cowan ML, Feingold DL, Steele SR; Clinical Practice Guidelines Committee of the American Society of Colon and Rectal Surgeons. The American Society of Colon and Rectal Surgeons' Clinical Practice Guidelines for the Management of Pilonidal Disease. Dis Colon Rectum. 2019;62:146-157.
11. Kaymakcioglu N, Yagci G, Simsek A, Unlu A, Tekin OF, Cetiner S, Tufan T. Treatment of pilonidal sinus by phenol application and factors affecting the recurrence. Tech Coloproctol. 2005;9:21-24.
12. Stauffer VK, Luedi MM, Kauf P, Schmid M, Diekmann M, Wieferich K, Schnüriger B, Doll D. Common surgical procedures in pilonidal sinus disease: A meta-analysis, merged data analysis, and comprehensive study on recurrence. Sci Rep. 2018;8:3058.
13. Muzi MG, Milito G, Cadeddu F, Nigro C, Andreoli F, Amabile D, Farinon AM. Randomized comparison of Limberg flap versus modified primary closure for the treatment of pilonidal disease. Am J Surg. 2010;200:9-14.
14. Testini M, Piccinni G, Miniello S, Di Venere B, Lissidini G, Nicolardi V, Bonomo GM. Treatment of chronic pilonidal sinus with local anaesthesia: a randomized trial of closed compared with open technique. Colorectal Dis. 2001;3:427-430.
15. Karydakis GE. Easy and successful treatment of pilonidal sinus after explanation of its causative process. Aust N Z J Surg. 1992;62:385-389.
16. Stansby G, Greatorex R. Phenol treatment of pilonidal sinuses of the natal cleft. Br J Surg. 1989;76:729-730.
17. Omarov N, Kaya M. Outcomes of crystallized phenol treatment in sacrococcygeal pilonidal sinus disease and factors affecting recurrence: a retrospective study. Turk J Colorectal Dis. 2024;34:7-12.
18. Steele SR, Perry WB, Mills S, Buie WD; Standards Practice Task Force of the American Society of Colon and Rectal Surgeons. Practice parameters for the management of pilonidal disease. Dis Colon Rectum. 2013;56:1021-1027.
19. Emile SH, Elfeki H, Shalaby M, Sakr A, Giaccaglia V, Sileri P, Wexner SD. Endoscopic pilonidal sinus treatment: a systematic review and meta-analysis. Surg Endosc. 2018;32:3754-3762.
20. Dessily M, Dziubeck M, Chahidi E, Simonelli V. The SiLaC procedure for pilonidal sinus disease: long-term outcomes of a single institution prospective study. Tech Coloproctol. 2019;23:1133-1140.
21. Kumar M, Clay WH, Lee MJ, Brown SR, Hind D. A mapping review of sacrococcygeal pilonidal sinus disease. Tech Coloproctol. 2021;25:675-682.

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BRIEF REPORT

Developing a Standardized Curriculum for Robotic Colorectal Surgery for General Surgery Residents: Experience from a Tertiary Center

Betty Chang[1], Eren Esen[1], Chady Atallah[2]

[1]New York University Grossman School of Medicine, Department of Surgery, New York, USA
[2]New York University Grossman School of Medicine, Division of Colorectal Surgery, General Surgery Residency Program Director, New York, USA

ABSTRACT

Robotic platforms are being adopted in surgery at an increasingly rapid pace, with implications for the field of general surgery and residency training. This evolution has prompted discussion on the ideal methods used to train current surgical residents in the use of robotic platforms.

The colorectal surgery department at our institution has implemented a standardized robotic surgery curriculum designed to establish clear expectations for residents' progression, autonomy, and the skills that should be acquired by the conclusion of their training. The curriculum outlines key surgical objectives, representing essential steps that require distinct skills and anatomical knowledge, organized by postgraduate year level as a general guide to the resident's ability.

The goals of this standardized curriculum include increasing resident engagement in acquiring robotic skills, dividing complete procedures into manageable steps and objectives, and promoting faculty participation to allow residents to operate independently, within defined competency levels. Upon completion of the curriculum, residents report confidence in performing common robotic colorectal surgeries.

We aim to expand the implementation of this curriculum model to other departments within our institution and encourage the adoption of similar standardized robotic training by other academic centers in this new era of robotic surgery.

To underscore the benefits and importance of a standardized robotic surgery curriculum for residents with our experience in the division of colorectal surgery.

Keywords: Surgical education, robotic surgery, robotic curriculum, standardized curriculum

Introduction

Over the last decade, the field of general surgery has adopted robotic platforms at a remarkably rapid pace. According to a 2019 cohort study of 72 hospitals, the use of robots in general surgery procedures increased from 1.8% to 15.1% between 2012 and 2018.[1] Consequently, general surgery residents have experienced substantial changes in the types of cases they are exposed to and in the skills required to become proficient surgeons in a changing landscape. This shift has sparked discussion regarding the most effective methods to prepare and train surgical residents in robotic skills.

In 2024, a working group of minimally invasive surgeons and robotic educators was formed to develop recommendations for a standardized, transferable curriculum that could be implemented in residency programs across the US[2] The group's recommendations included preliminary simulator practice and hands-on experience with bedside assistance and console operation, with an emphasis on well-defined tiers based on

Address for Correspondence: Betty Chang MD,
New York University Grossman School of Medicine, Department of Surgery, New York, USA
E-mail: Betty.chang@nyulangone.org **ORCID ID:** orcid.org/0000-0002-7784-7694
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specific objectives that residents must meet to progress.

At our institution, we developed a standardized robotic curriculum that is distributed to residents at the beginning of their training to establish clear expectations for their progression, autonomy, and the skills to be mastered by the conclusion of their training. The goals of this curriculum include increasing resident engagement in acquiring robotic skills, breaking up specific full procedures into manageable steps and objectives, and increasing faculty engagement to allow residents to operate independently, provided there is a mutual understanding of the resident's "level" or achieved objectives. We believe that residents should be able to participate in appropriate portions of procedures based on their level of training.

This philosophy has permeated the entire department, and colorectal surgery rotations are now highly regarded by residents at all levels due to the clear expectations and operative autonomy. To facilitate understanding of the cases and individual steps, residents are granted access to case recordings from all robotic cases across services. This initiative allows them to better prepare for specific cases and attending surgeons and to improve their skills by analyzing their intraoperative performance.

Methods and Curriculum Development

The robotic curriculum was developed by faculty and residents within the department of colorectal surgery. No informed consent was required for this process.

Outlined below is our standardized robotic curriculum for common colorectal procedures, including right and left colectomy, low anterior resection, and Hartmann's reversal (Table 1). Each operation includes objectives representing key steps of the surgery that require distinct skills and anatomical knowledge. These objectives are organized by postgraduate year (PGY) level, which serves as a general guide for the resident's skill level. However, residents may work on objectives above or below their PGY level depending on their prior exposure to the operation or their overall skill level.

Table 1. Robotic surgery curriculum

Right colectomy/ileocolic resection
1. **PGY5:** Isolate and ligate the ileocolic vessels (when applicable) using clips, stapler, or energy device.
2. **PGY3+:** Perform medial to lateral dissection: use sharp and blunt dissection to separate the colon mesentery from the retroperitoneum; identify and dissect the duodenum.
3. **PGY3+:** Perform inferior to superior dissection (alternate technique): use sharp and blunt dissection to separate the colon mesentery from the retroperitoneum; identify and dissect the duodenum.
4. **PGY1+:** Perform lateral takedown of the white line of Toldt and hepatic flexure takedown.
5. **PGY3+:** Staple robotically across the colon and ileum.
6. **PGY5+:** Perform the side-to-side anastomosis.
7. **PGY3+:** Oversew the resulting enterotomy (two-layer closure); PGY1 may perform the outer layer closure.
8. **PGY1+:** Extract the specimen using an Alexis wound protector; close the fascia.
9. **PGY1+:** Provide bedside assistance as indicated (suction, exposure, retraction).
Left colectomy/sigmoidectomy
1. **PGY5:** Isolate and ligate the inferior mesenteric vessels (IMA and IMV, when applicable) using clips, stapler, or energy device.
2. **PGY3+:** Perform medial to lateral dissection: use sharp and blunt dissection to separate the colon mesentery from the retroperitoneum.
3. **PGY5:** Identify and protect the ureter.
4. **PGY1+:** Perform lateral takedown of the white line of Toldt.
5. **PGY3+:** Mobilize the splenic flexure (enter the lesser sac, take down the gastrocolic ligament, and separate from the lower edge of the pancreas).
6. **PGY3+:** Staple robotically across the colon.
7. **PGY1+:** Extract the specimen through the extraction site (Pfannenstiel).
8. **PGY1+:** Secure the anvil to the colon extracorporeally.
9. **PGY3+:** Perform the colorectal anastomosis.
10. **PGY1+:** Manipulate and deploy the EEA stapler.
11. **PGY1+:** Perform the air leak test/flexible sigmoidoscopy.
12. **PGY1+:** Provide bedside assistance as indicated (suction, exposure, retraction).

Table 1. Continued

Right colectomy/ileocolic resection
Low anterior resection
1. **Steps 1-12 as described for the left colectomy/sigmoidectomy.**
2. **PGY5:** Perform the pelvic dissection (total mesorectal excision).
3. **PGY5:** Transect the rectum distal to the level of the tumor.
Hartmann reversal
1. **PGY1+:** Take down the colostomy to the level of the fascia.
2. **PGY5:** Isolate and ligate the inferior mesenteric vessels (IMA and IMV, when applicable) using clips, stapler, or energy device.
3. **PGY3+:** Mobilize the splenic flexure (enter the lesser sac, take down the gastrocolic ligament, and separate from the lower edge of the pancreas).
4. **PGY3+:** Transect the sigmoid stump (when applicable).
5. **PGY1+:** Secure the anvil to the colon extracorporeally.
6. **PGY3+:** Perform the colorectal anastomosis.
7. **PGY1+:** Manipulate and deploy the EEA stapler.
8. **PGY1+:** Perform the air leak test/flexible sigmoidoscopy.
9. **PGY1+:** Provide bedside assistance as indicated (suction, exposure, retraction).

PGY: Postgraduate year

Discussion

It has been over a year since the implementation of our standardized curriculum. Residents have expressed high satisfaction with the opportunity to acquire progressively advanced skills and perform increasingly complex portions of colorectal operations.

The Cognitive Load Theory, developed by John Sweller in 1988, describes how the brain's working memory can be easily overwhelmed, leading to decreased information retention once capacity is exceeded. Effective strategies to reduce cognitive load include breaking down larger, more intimidating tasks into smaller steps and building upon prior knowledge. For this reason, our robotic curriculum was designed to provide digestible, concrete objectives that learners can build upon to achieve their ultimate goal.

Other institutions, such as the University of Illinois College of Medicine at Peoria, have developed robotics curricula that combine simulation and hands-on training for small groups of participants. During the hands-on portion, residents began with the simplest operative tasks and then progressed to increasingly complex ones. Their study showed improved resident performance with higher numbers of procedures performed in this sequential manner and, as they stated, underscores the importance of a "methodical, stepwise robotics curriculum".[3]

Feedback from both residents and faculty at our institution has been extremely positive. Residents report that they have been able to progress rapidly through the outlined colorectal procedures, with more time spent on the console in the operating room. They have reported that attending surgeons are more comfortable letting them perform increasingly complex steps of the procedure, knowing that they have progressed adequately through the curriculum. However, the most demonstrative fact may be that at the end of their general surgery training, our residents can confidently perform complex robotic colorectal operations.

Conclusion

We have developed a standardized robotic curriculum specific to the colorectal surgery department at our institution. This curriculum incorporates small operative steps organized by PGY level, representing tasks of increasing complexity that ultimately build into the completion of a procedure. This is a time-efficient, goal-oriented, and competency-based method that has contributed to our surgical training program being recognized as providing one of the most rewarding and formative operative experiences in the country.

Upon completion of the curriculum, residents report feeling confident in performing common robotic colorectal surgeries. Future steps include continued development of an online video database to supplement hands-on training and provide learners with visual demonstrations of curriculum objectives prior to performing them. Additionally, we aim to implement similar curricula in other departments within our institution and encourage other academic centers to consider adopting their own standardized robotic learning in this new era of robotic surgery.

Footnotes

Authorship Contributions

Concept: B.C., E.E., C.A., Design: B.C., E.E., C.A., Data Collection or Processing: B.C., E.E., Analysis or Interpretation: B.C., E.E., C.A., Literature Search: B.C., E.E., Writing: B.C., E.E., C.A.

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REFERENCES

1. Sheetz KH, Claflin J, Dimick JB. Trends in the adoption of robotic surgery for common surgical procedures. JAMA Netw Open. 2020;3:e1918911.
2. Porterfield JR Jr, Podolsky D, Ballecer C, Coker AM, Kudsi OY, Duffy AJ, Meara MP, Novitsky YW. Structured resident training in robotic surgery: recommendations of the Robotic Surgery Education Working Group. J Surg Educ. 2024;81:9-16.
3. Moit H, Dwyer A, De Sutter M, Heinzel S, Crawford D. A standardized robotic training curriculum in a general surgery program. JSLS. 2019;23:e2019.

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CASE REPORT

Colonic Obstruction Due to *Blastocystis hominis* Infestation: A Rare Case Report

Çağıl Karaevli[1], Sami Acar[2]

[1]Torbalı State Hospital, Clinic of General Surgery, İzmir, Türkiye
[2]Tekirdağ Namık Kemal University Faculty of Medicine, Department of General Surgery, Tekirdağ, Türkiye

ABSTRACT

Blastocystis hominis (B. hominis) is an intestinal parasite that is usually asymptomatic and transmitted by the feco-oral route. It is commonly found in human and animal fecal samples. The role of *Blastocystis* in human health and disease is controversial. Studies have shown a relationship between subtypes and symptom presentation. Patients frequently present with abdominal pain, nausea, bloating, and diarrhea. In our case, intestinal obstruction was observed, which is the exact opposite of the usual *B. hominis* symptoms. The patient was evaluated for malignancy. On radiologic examination, the appearance of an almost complete obstruction of the distal sigmoid colon passage was highly suspicious of malignancy. An endoscopic evaluation revealed a mass almost completely obstructing the lumen. Malignancy was not pathologically confirmed. We performed surgical treatment in accordance with oncologic principles.

This study aimed to share our experience in the diagnosis and treatment of an obstructive mass caused by a single-celled organism.

Keywords: *Blastocystis hominis*, colon, ileus, infestation, obstruction

Introduction

Blastocystis hominis (B. hominis) is an anaerobic protozoan parasite found in the gastrointestinal tract of humans and animals.[1] *Blastocystis spp.* are the most commonly detected eukaryotic parasites in human stool specimens. *Blastocystis* was first described by Alexieff in 1911 and subsequently given its worldwide name by Brumpt in 1912. Currently, at least 13 subtypes have been identified due to morphological and genetic variations. Subtype 3 is the most frequently isolated genotype in epidemiologic studies.[2] Pathologic effects may depend on host factors, such as lowered immunity, or disturbances in gastrointestinal function caused by other factors. The prevalence in humans ranges from 0.5% to 24% in industrialized countries and from 30% to 76% in developing countries.[3,4]

B. hominis may manifest in patients with symptoms such as diarrhea, nausea, loss of appetite, abdominal cramps, bloating, gas, urticaria, itching, and fatigue. Typically, the diagnosis of *B. hominis* is established through direct microscopic examination of fecal samples processed with trichrome stain and the Kinyoun acid-fast technique. Polymerase chain reaction (PCR) techniques are highly sensitive and are becoming increasingly common.[5,6] Endoscopic findings usually show a macroscopically normal-appearing mucosa. The parasite typically does not invade tissues.[7-9]

The differential diagnosis includes intestinal malabsorption syndromes, such as celiac disease and inflammatory bowel diseases. It is not necessary to treat asymptomatic patients identified through stool examination, as *Blastocystis spp.* are commensal organisms. Metronidazole, tinidazole, and paromomycin play an important role in the medical treatment of symptomatic patients.

Case Report

A 47-year-old male patient was referred to the general surgery clinic with complaints of abdominal pain, recent constipation, intermittent fever, and weight loss. He had no known

Address for Correspondence: Çağıl Karaevli MD, Torbalı State Hospital, Clinic of General Surgery, İzmir, Türkiye
E-mail: karaevlicagil@yahoo.com **ORCID ID:** orcid.org/0000-0002-4280-7430
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comorbidities and no history of surgery. The patient had no family history suggestive of parasitic infection or malignancy. Physical examination revealed left lower quadrant tenderness. Sedimentation rates were slightly above the upper limit, whereas other biochemical parameters remained normal. According to ultrasonography, there was no intra-abdominal free fluid, and the small bowel diameters appeared mildly increased. A computed tomography scan displayed a massive soft tissue lesion in the proximal 85 mm segment of the sigmoid colon, with marked narrowing of the lumen, as well as contamination of the surrounding fatty planes and lymph nodes with a short axis <1 cm (Figure 1). On endoscopic examination, the colonic mucosa was irregular, edematous, and fragmented in the area corresponding to the sigmoid colon. Erosions and sporadic ulcers were observed. It was not possible to proceed proximally from this area where the lumen was narrowed (Figure 2). Endoscopic biopsies revealed focal adenomatous changes and were diagnosed as chronic non-specific colitis. During the evaluation, the patient developed abdominal distension. His condition was reviewed by the oncology council. Low anterior resection with colorectal anastomosis and diversion ileostomy was performed according to oncologic principles. Infiltration was seen in the upper left side of the bladder. Partial resection was applied to this region (Figure 3). Pathologic evaluation of the specimen revealed areas of ulceration extending into the muscular layer. However, no evidence of malignancy was found. A microbiology opinion was requested for diagnosis. It was reported that microorganisms compatible with parasites featuring eosinophilic cytoplasm and large nuclei were observed among the dense inflammation, leading to a consideration of invasive parasitic infection (Figure 4). The diagnosis of *Blastocystis* infestation was confirmed by PCR. The patient was referred to the infectious diseases department, where he received metronidazole at a dosage of 500 mg every 8 hours. After a 3-month follow-up, complete eradication of *B. hominis* was confirmed. Ileostomy closure was performed in the 4th week post-operation.

The patient provided informed consent for publication.

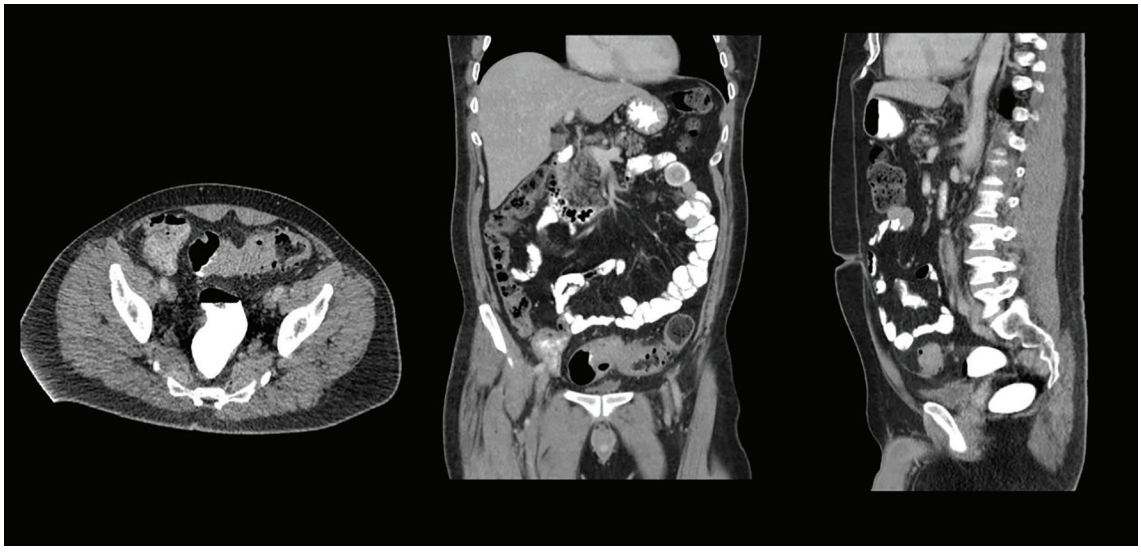

Figure 1. Computed tomography images. A narrowed rectosigmoid junction is seen in the axial plane. A dilated segment is demonstrated in the coronal plane and a suspicious infiltration with the bladder wall in the sagittal plane

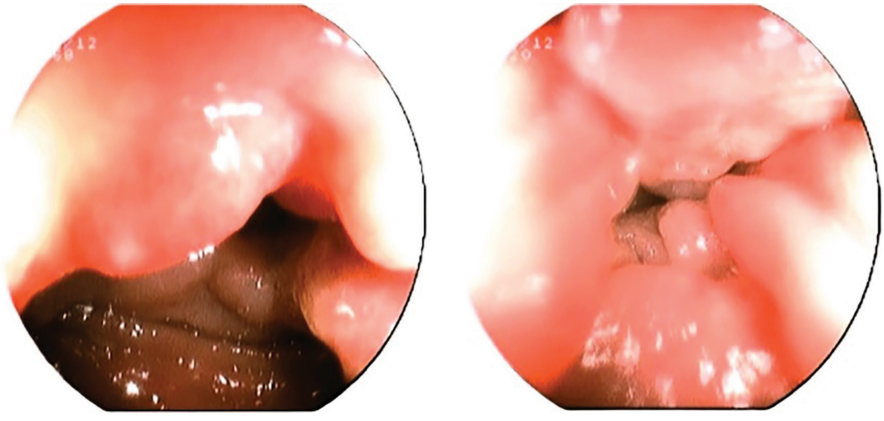

Figure 2. Obstructive, edematous, and fragile mucosal areas at the endoscopic examination

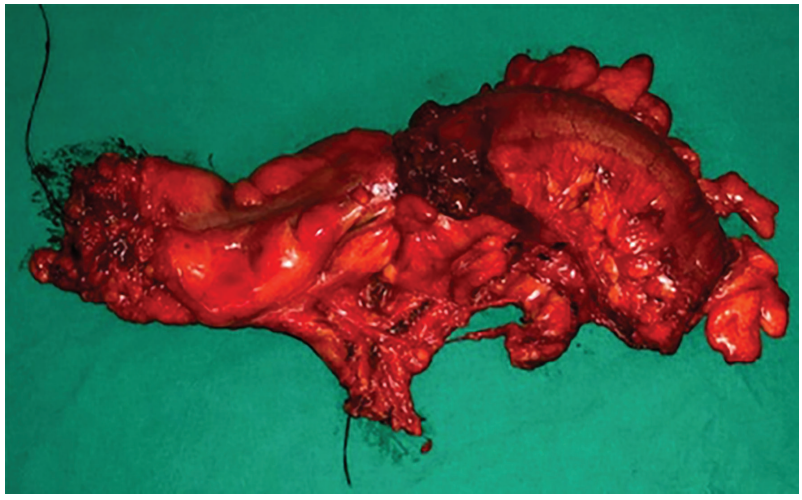

Figure 3. Peroperative macroscopic view (Blastocystis infestation is indicated with the yellow arrow)

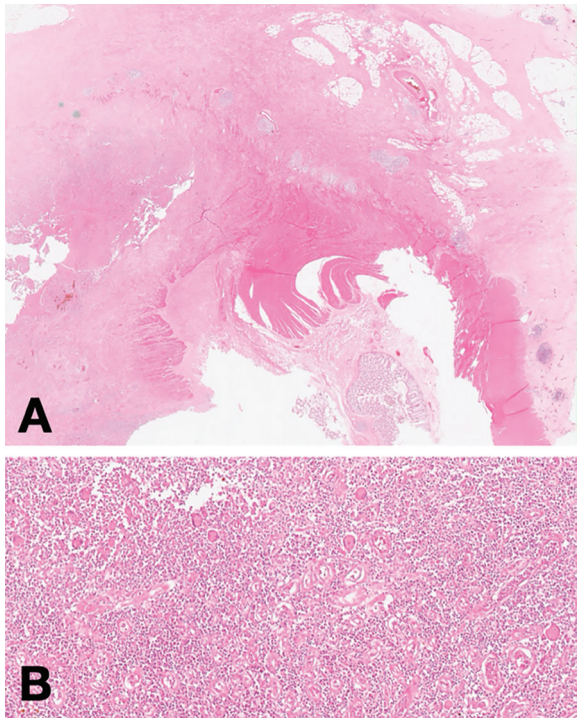

Figure 4. Histopathological views of the obstructed colonic segment
A) Ulcerated area in the muscularis mucosa of the colonic epithelium, H&E x4, **B)** Giant cell-like microorganisms among intense inflammation, H&E x100
H&E: Hematoxylin and eosin

Discussion

The pathogenicity of *B. hominis* remains controversial, and there is ongoing debate regarding whether treatment is warranted.[10] Some clinicians consider treatment necessary if no other infectious agent is detected and symptoms are attributed to *B. hominis*. In recent years, several studies have reported on symptomatic patients. Some have even studied the relationship between *Blastocystis spp.* and inflammatory bowel diseases, various cutaneous lesions, and intestinal malignancies. Although *Blastocystis* infections cause gastrointestinal symptoms ranging from diarrhea to constipation, we did not expect to encounter an isolated obstructive mass. Horiki et al.[11] presented four patients with *B. hominis*-positive occlusive intestinal cancer. They aimed to demonstrate that cancerous neoplasms can create a suitable environment for the parasite to proliferate. Horiki et al.[11] concluded that *B. hominis* infection in four cases was incidental and unrelated to neoplastic growths. They also did not detect a specific localization for *Blastocystis* colonizations. In all four instances, the obstructive

zone was located in the ileum, transverse colon, sigmoid colon, and rectosigmoid junction, respectively. In our case, we faced an isolated *Blastocystis* infestation at the rectosigmoid junction. In several animal studies, penetration of *Blastocystis spp.* into the intestinal epithelium and colonic distension were observed.[12] In contrast to our case, Horiki et al.[11] reported that histological examination of resected cancerous lesions did not invade into the mucosa by the organism even when large numbers of *B. hominis* were found in fecal samples.

B. hominis infection may be associated with mucosal ulcers, as reported in a few cases in the literature.[13] Lintong et al.[14] showed with their case report that *B. hominis* invaded and destroyed the mucous layers of the appendix. In the presence of an occlusive mass, the diagnosis-treatment process can be challenging. When radiologic and endoscopic evaluations lead to suspicion of a malignant mass, time becomes an important factor for curative treatment. Diarrhea, the most common symptom of *Blastocystis* infection, was not seen in our case. The *Blastocystis* infestation mimics an occlusive mass; therefore, *Blastocystis* infection should be considered in the differential diagnosis when histopathologic findings are inconclusive.

Ethics

Informed Consent: An informed consent was obtained from the patient for this case report.

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Footnotes

Authorship Contributions

Surgical and Medical Practices: Ç.K., S.A., Concept: S.A., Design: Ç.K., Data Collection or Processing: Ç.K. S.A., Analysis or Interpretation: S.A., Literature Search: Ç.K. S.A., Writing: Ç.K.

Conflict of Interest: The authors declare that they have no conflicts of interest relevant to the content of this article.

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REFERENCES

1. Tan KS. New insights on classification, identification, and clinical relevance of *Blastocystis* spp. Clin Microbiol Rev. 2008;21:639-665.
2. Wong KH, Ng GC, Lin RT, Yoshikawa H, Taylor MB, Tan KS. Predominance of subtype 3 among *Blastocystis* isolates from a major hospital in Singapore. Parasitol Res. 2008;102:663-670.
3. Bart A, Wentink-Bonnema EM, Gilis H, Verhaar N, Wassenaar CJ, van Vugt M, Goorhuis A, van Gool T. Diagnosis and subtype analysis of *Blastocystis* sp. in 442 patients in a hospital setting in the Netherlands. BMC Infect Dis. 2013;13:389.
4. Stensvold CR, Nielsen HV, Mølbak K, Smith HV. Pursuing the clinical significance of *Blastocystis*--diagnostic limitations. Trends Parasitol. 2009;25:23-29.
5. Jones MS 2nd, Ganac RD, Hiser G, Hudson NR, Le A, Whipps CM. Detection of *Blastocystis* from stool samples using real-time PCR. Parasitol Res. 2008;103:551-557.
6. Roberts T, Barratt J, Harkness J, Ellis J, Stark D. Comparison of microscopy, culture, and conventional polymerase chain reaction for detection of *blastocystis* sp. in clinical stool samples. Am J Trop Med Hyg. 2011;84:308-312.
7. Zuckerman MJ, Watts MT, Ho H, Meriano FV. *Blastocystis hominis* infection and intestinal injury. Am J Med Sci. 1994;308:96-101.
8. Horiki N, Maruyama M, Fujita Y, Yonekura T, Minato S, Kaneda Y. Epidemiologic survey of *Blastocystis hominis* infection in Japan. Am J Trop Med Hyg. 1997;56:370-374.
9. Zuckerman MJ, Ho H, Hooper L, Anderson B, Polly SM. Frequency of recovery of *Blastocystis hominis* in clinical practice. J Clin Gastroenterol. 1990;12:525-532.
10. Cobuccio LG, Laurent M, Gardiol C, Wampfler R, Poppert S, Senn N, Eperon G, Genton B, Locatelli I, de Vallière S. Should we treat *Blastocystis* sp.? A double-blind placebo-controlled randomized pilot trial. J Travel Med. 2023;30:taac143.
11. Horiki N, Kaneda Y, Maruyama M, Fujita Y, Tachibana H. Intestinal blockage by carcinoma and *Blastocystis hominis* infection. Am J Trop Med Hyg. 1999;60:400-402.
12. Phillips BP, Zierdt CH. *Blastocystis hominis*: pathogenic potential in human patients and in gnotobiotes. Exp Parasitol. 1976;39:358-364.
13. Sutanto I, Ismid IS, Sjarifuddin PK, Sungkar S. In: Sutanto I, Ismid IS, Sjarifuddin PK, Sungkar S, eds. Textbook of Medical Parasitology. 4th ed. Jakarta: Faculty of Medicine, University of Indonesia; 2008:179-183.
14. Lintong PM, Sambuaga MK, Tambajong EH. Acute suppurative appendicitis with *Blastocystis hominis*. Asian Pac J Trop Dis. 2012;2:S965-S968.

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CASE REPORT

Well-Differentiated Neuroendocrine Tumor of the Appendix Presenting as Acute Phlegmonous Appendicitis: A Case Report

Radomir Gelevski[1], Gjorgji Jota[2], Blagica Krsteska[3], Vesna Jovanovska Manevska[1], Bojan Trenchikj[1], Natasha Jovanovska[1]

[1]General Hospital Kumanovo, Clinic of Surgery, Kumanovo, North Macedonia
[2]Ss Cyril and Methodius University in Skopje, Clinic for Digestive Surgery, Skopje, North Macedonia
[3]Ss Cyril and Methodius University in Skopje, Faculty of Medicine, Institute of Pathology, Skopje, North Macedonia

ABSTRACT

A 26-year-old man underwent appendectomy for acute phlegmonous appendicitis, and postoperative histopathology revealed a well-differentiated appendiceal neuroendocrine tumor (NET) (G1, 1.3 cm, Ki-67 <1%), confined to the subserosa without mesoappendiceal invasion or lymphovascular/perineural involvement. Surgical margins were clear, and the patient recovered uneventfully. According to guidelines, right hemicolectomy is selectively considered for 1-2 cm tumors with high-risk features. As none were present, appendectomy was deemed sufficient following a multidisciplinary team review. This case highlights the importance of thorough histopathological assessment and individualized management of incidentally detected appendiceal NETs within the 1-2 cm gray-zone category.

Keywords: Appendiceal neuroendocrine tumor, appendix, acute appendicitis, histopathology, incidental tumor, case report

Introduction

Appendectomy remains one of the most common emergency surgical procedures worldwide. Although most cases are straightforward inflammatory conditions, unexpected neoplasms of the appendix may be encountered histologically.[1,2] Neuroendocrine tumors (NETs) are the most common primary neoplasms of the appendix, representing 0.3%-0.9% of all appendectomy specimens.[3,4] They typically occur in young adults, often with female predominance, and are usually diagnosed incidentally. Most appendiceal NETs are well-differentiated, have an indolent course, and are considered to have a favorable prognosis when small (<2 cm). However, larger lesions or those with mesoappendiceal or serosal invasion may require further oncological evaluation and extended surgical resection.[1,2,5]

We present a case of appendiceal NET discovered during histological examination following appendectomy for acute phlegmonous appendicitis.

Case Presentation

A 26-year-old male patient was admitted as an emergency case due to acute abdominal pain with a 2-day history of symptoms. The pain started in the epigastrium and localized to the right iliac fossa. The patient was febrile (38°C), with nausea, repeated vomiting, and loss of appetite. Past medical history was negative for hepatic, renal, or malignant diseases, and no drug allergies were reported. The patient had marked tenderness in the right lower quadrant on superficial and deep palpation. Laboratory results were as follows: white blood cell count =8×10^9/L, neutrophil-to-lymphocyte ratio (NLR) =2.55, C-reactive protein (CRP) = 56.5 mg/L, procalcitonin = 0.08 ng/

Address for Correspondence: Radomir Gelevski MD,
General Hospital Kumanovo, Clinic of Surgery, Kumanovo, North Macedonia
E-mail: radomirgelevski@hotmail.com **ORCID ID:** orcid.org/0009-0005-2108-8595
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mL, CRP-to-albumin ratio =1.26, and total bilirubin =22.9 µmol/L. Peripheral blood smear showed normal erythrocyte morphology, and viral hepatitis serology was negative. Contrast-enhanced abdominal computed tomography demonstrated an edematous appendix with absent luminal visualization, mild periappendicular fat stranding, and three calcified fecaliths (up to 8 mm) at the cecal ostium (Figure 1). Such findings are consistent with phlegmonous appendicitis.[6]

Appendectomy was performed. Intraoperatively, the appendix was inflamed and phlegmonous. A swab from the appendiceal lumen and mucosal sample was taken for microbiology. Culture yielded *Pseudomonas aeruginosa*, *Enterococcus spp.*, and *Escherichia coli*.

Histopathology confirmed the appendix measured 7.0×0.6 cm, with mesoappendiceal fat up to 2.5 cm. Serosa was dull with purulent deposits. Toward the tip, a whitish solid mass (1.3 cm diameter) was noted. On microscopy, the appendiceal wall showed ulcerated mucosa with luminal hemorrhagic-purulent contents and transmural acute inflammation. The whitish solid area consisted of nests of uniform oval cells with light cytoplasm and "salt-and-pepper" chromatin infiltrating through all layers into the subserosa. Mitotic figures were rare (1/10 high-power field) (Figure 2). Immunohistochemistry confirmed the following: chromogranin a (+) (Figure 3), synaptophysin (+) (Figure 4), Ki-67 <1% (Figure 5).

The final diagnosis was as follows: well-differentiated NET of the appendix, G1, pT3, with subserosal and no mesoappendiceal invasion, clear surgical margins, and no lymphovascular or perineural invasion.

The patient had an uneventful recovery and was discharged on postoperative day 2 in good general condition. After receiving the pathohistological findings, the case was presented to the multidisciplinary tumor board (MDT). According to guidelines, right hemicolectomy (RHC) is selectively considered for 1-2 cm tumors with high-risk features. As none were present, appendectomy was deemed sufficient following a multidisciplinary team review. The patient was scheduled for regular follow-ups.

Discussion

Appendiceal NETs are most frequently encountered incidentally in appendectomy specimens for suspected appendicitis. In many cases, the presenting symptoms result from luminal obstruction by the tumor, leading to inflammation, as in this case.[3,4] The diagnosis is rarely made preoperatively because imaging and laboratory parameters typically reflect only inflammatory changes. Our patient presented with moderately elevated inflammatory markers (CRP =56.5 mg/L, NLR =2.55) and mild hyperbilirubinemia, findings consistent with complicated appendicitis but not specific for underlying neoplasia.[6,7]

Histological examination confirmed a well-differentiated NET (G1), characterized by uniform cytology, low mitotic activity, and a low Ki-67 proliferation index. Importantly, the tumor infiltrated the entire appendiceal wall into the subserosa (pT3), which has prognostic and therapeutic implications.[1,2] Both the European Neuroendocrine Tumor Society (ENETS) and North American Neuroendocrine Tumor Society (NANETS) agree that tumors <1 cm are adequately treated with appendectomy alone, whereas those >2 cm generally warrant RHC with lymphadenectomy due to a significantly higher risk of nodal metastases.[1,2] The main area of controversy lies in the

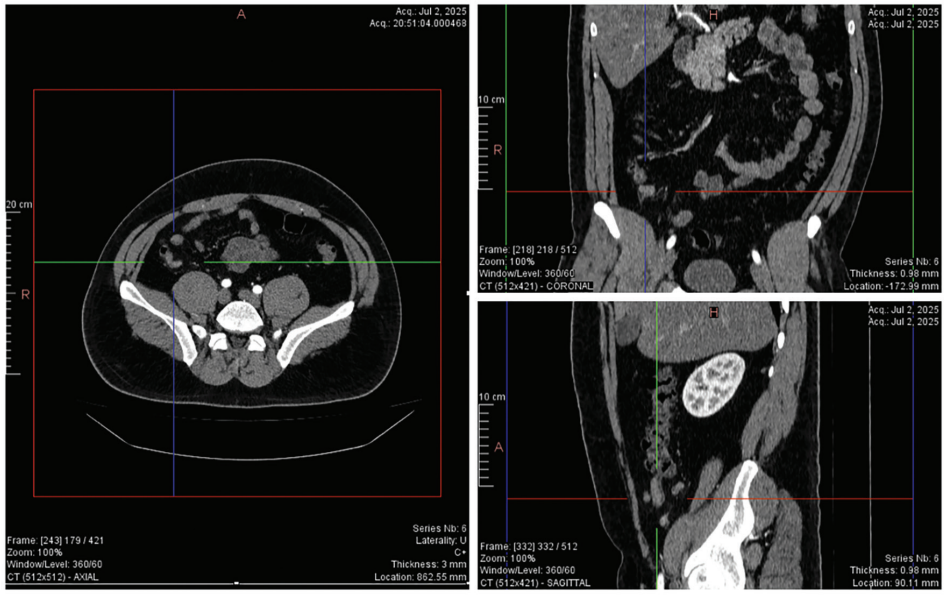

Figure 1. Contrast-enhanced abdominal computed tomography horizontal, coronal, and sagittal views, demonstrating an edematous appendix with absent luminal visualization, mild periappendicular fat stranding

management of tumors measuring 1-2 cm, the so-called "gray zone."

For this group, ENETS and NANETS advocate a selective approach; RHC should be considered if high-risk features are present, such as mesoappendiceal invasion >3 mm, positive or close resection margin, tumor located at the appendiceal base, lymphovascular or perineural invasion, or higher proliferative index.[1-3] The ENETS 2023 update emphasizes a multifactorial risk assessment and stresses the importance of MDT discussion.[1] Similarly, NANETS guidelines (2022-2024) support individualized management and discourage routine RHC in the absence of high-risk factors.[2]

In contrast, the National Comprehensive Cancer Network guidelines tend to be more permissive, often accepting appendectomy alone for 1-2 cm tumors, even in the presence of some risk features[4], whereas European Society for Medical Oncology guidance generally mirrors the ENETS/NANETS approach but also defers to MDT decision-making.[5]

Outcomes data reinforce this selective strategy. Large retrospective studies show no consistent overall survival benefit for routine RHC in 1-2 cm NETs, especially when margins are negative and no additional risk factors exist.[6,7] Nonetheless, RHC offers the advantage of nodal staging and may reduce locoregional recurrence risk in selected patients.[6,7]

Our patient's tumor measured 1.3 cm, was well differentiated (G1, Ki-67 <1%), and extended through the wall into the subserosa (pT3). This fulfills one of the potential risk factors —depth of invasion— but the crucial discriminator in most guidelines is the millimetric depth of mesoappendiceal invasion (>3 mm). Our pathology report described "subserosal infiltration" without mesoappendiceal, lymphovascular, or perineural invasion.

This case highlights the clinical challenge of managing appendiceal NETs in the 1-2 cm gray zone. Although mesoappendiceal invasion was absent (only subserosal invasion with intact serosa), the absence of additional high-risk features (negative margins, no lymphovascular or perineural invasion) supports appendectomy alone, consistent with ENETS and NANETS guidance.

According to ENETS and NANETS, if mesoappendiceal invasion is >3 mm or if margins are positive/close, RHC would be advised. In the absence of these features, and given the favorable biology (G1, Ki-67 <1%), appendectomy alone may be adequate, with clinical surveillance. An MDT evaluation remains critical to guide final management.[1-3]

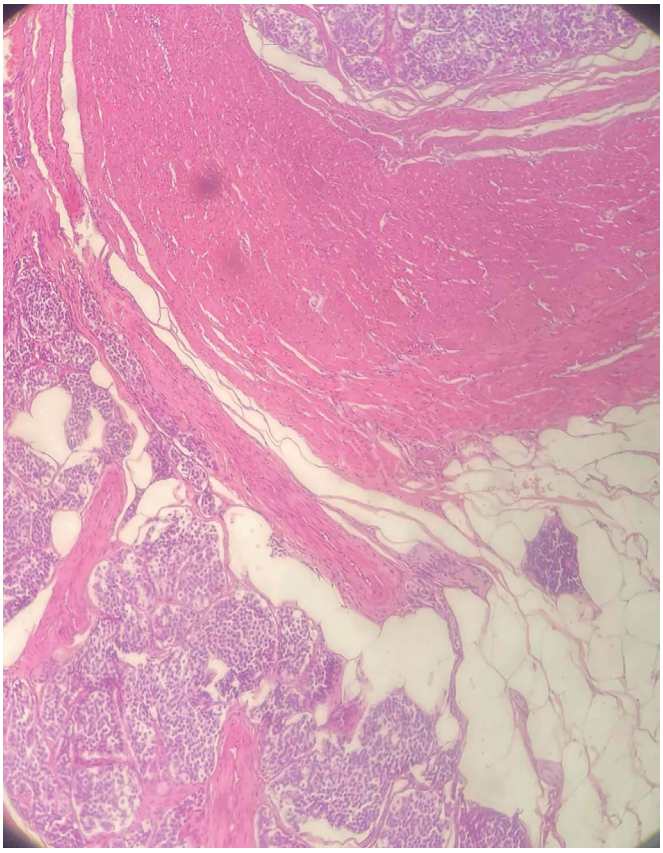

Figure 2. H&Ex100 Mural and subserosal infiltration. Nests of uniform oval cells with light cytoplasm and "salt-and-pepper" chromatin, infiltrating through all layers into the subserosa
H&E: Hematoxylin and eosin

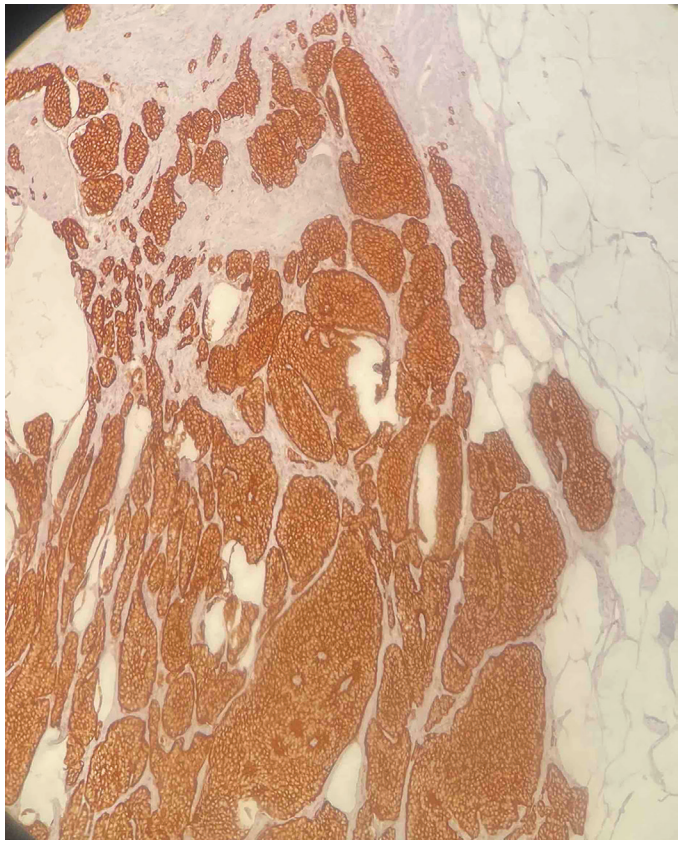

Figure 3. Chromogranin x100. Chromogranin is positive in tumor tissue

Limitations: As a single case report, the findings have limited generalizability and cannot determine definitive management strategies. Larger series and prospective studies are required to refine risk stratification and surgical decision-making.

To strengthen the clinical relevance, we have added a comparative summary table (Table 1) of previously reported appendiceal NET cases, focusing on the 1-2 cm "gray zone." This expanded comparison further underscores that

Table 1. Comparative summary of published case reports of appendiceal neuroendocrine tumors and our case

	Reference/case (year)	Age/gender	Tumor size and grade*	High-risk features present	Management performed	Outcome/follow-up notes
1	This case (2025, this report)	26-year-old male	1.3 cm, G1 (Ki-67 <1%)	No mesoappendiceal invasion; clear margins; no LVI; no PNI	Appendectomy alone; MDT review	Uneventful recovery; no recurrence
2	Appiah et al.[8], (Incidental Grade 2 ANET)	28-year-old male	0.5 cm, G2 (Ki-67 ~5%)	Confined to submucosa; negative margins; no LVI	Appendectomy only	Good outcome; followed clinically
3	Bayhan et al.[9], (4026 appendectomies)	Multiple cases	Mean ~0.85 cm (range 0.3-2.5 cm)	Some with MAI/serosal invasion; rare LVI	Appendectomy for most; RHC if >2 cm or risk features	No recurrences in small, low-risk tumors, 1-year follow up
4	Hasan et al.[10], (young patient with nodal spread)	19-year-old female	G2 (size not clearly stated)	LVI present; metastatic lymph nodes	Appendectomy + RHC	6/27 nodes positive; limited 3-months follow-up
5	Villa et al.[11], (collision tumor with LAMN)	31-year-old female	ANET T3, G1, Ki-67 <1% (with LAMN)	Mesoappendiceal invasion; positive LAMN margin	Appendectomy + RHC	5-year follow-up; no recurrence

*LAMN: Low-grade appendiceal mucinous neoplasm, LVI: Lymphovascular invasion, PNI: Perineural invasion, MAI: Mesoappendiceal invasion, ANET: Appendiceal neuroendocrine tumor, RHC: Right hemicolectomy, MDT: Multidisciplinary tumor board

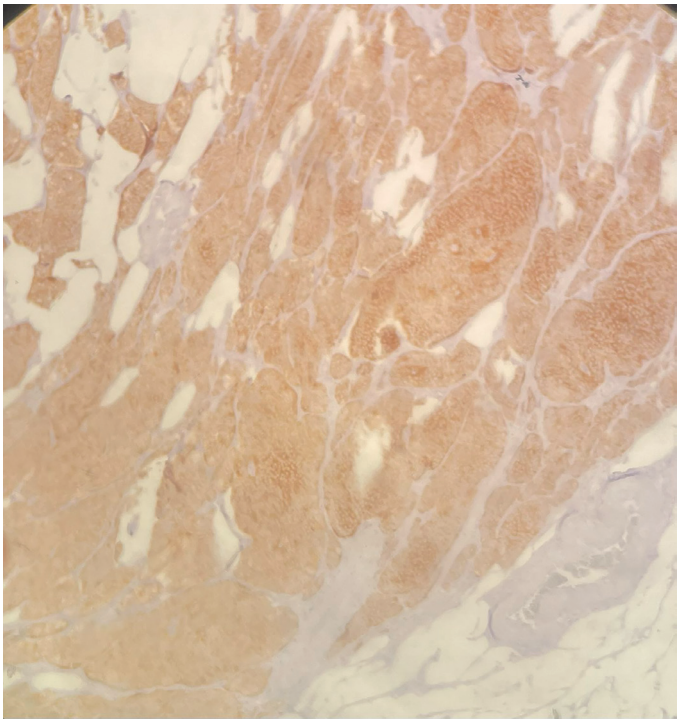

Figure 4. Synaptophysin x100. Synaptophysin is positive in tumor tissue

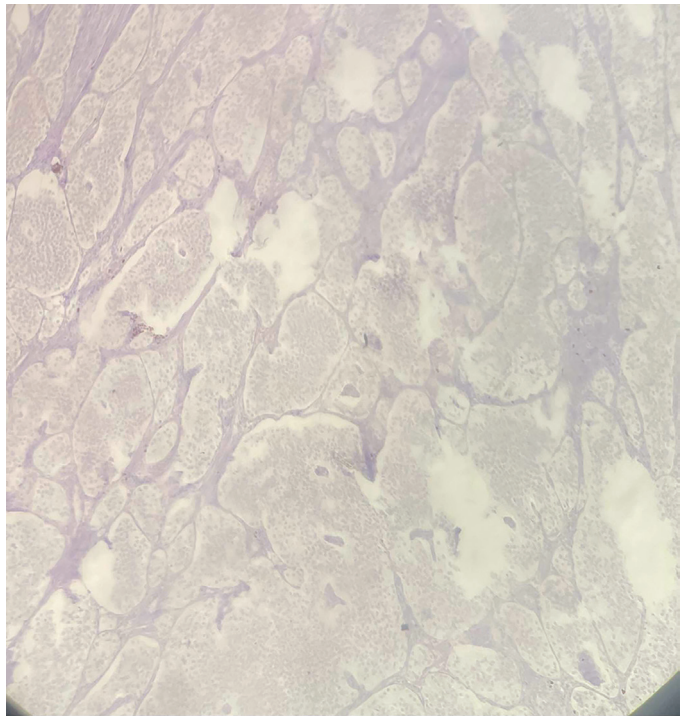

Figure 5. Ki-67 x100. Ki-67 proliferation index is very low (<1%) in tumor tissue

mesoappendiceal invasion, lymphovascular/perineural invasion, and positive or close surgical margins often drive the decision for RHC, whereas their absence—as in our patient—supports appendectomy alone.

Conclusion

We report a case of well-differentiated appendiceal NET presenting as acute phlegmonous appendicitis. Although rare, NETs should be considered in the differential diagnosis of appendiceal pathology. Histopathological examination remains essential for definitive diagnosis and guiding further management. Current ENETS and NANETS guidelines support selective RHC in tumors between 1-2 cm only when additional high-risk features are present. When viewed in the context of previously published reports (Table 1), our case supports the selective approach; RHC should be reserved for 1-2 cm tumors with additional high-risk features, and appendectomy alone may be sufficient in their absence. This reinforces the importance of precise histopathological assessment and individualized, multidisciplinary decision-making in the "gray zone."

Ethics

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: R.G., B.K., B.T., Concept: R.G., G.J., Design: R.G., G.J., Data Collection or Processing: R.G., B.K., V.J.M., B.T., N.J., Analysis or Interpretation: R.G., G.J., B.K., V.J.M., B.T., N.J., Literature Search: R.G., V.J.M., B.T., N.J., Writing: R.G., G.J., B.K., V.J.M., B.T., N.J.

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REFERENCES

1. Kaltsas G, Walter T, Knigge U, Toumpanakis C, Santos AP, Begum N, Pape UF, Volante M, Frilling A, Couvelard A. European Neuroendocrine Tumor Society (ENETS) 2023 guidance paper for appendiceal neuroendocrine tumours (aNET). J Neuroendocrinol. 2023;35:e13332.
2. Godfrey EL, Mahoney F, Bansal VV, Su DG, Hanna DN, Lopez-Ramirez F, Baron E, Turaga KK, Benson AB, Cusack J, Winer JH, Gunderson CG, Misdraji J, Shah R, Magge DR, Solsky I, Eng C, Eng OS, Shergill A, Shen JP, Foote MB; Peritoneal Surface Malignancies (PSM) Consortium Group. Consensus guideline for the management of patients with appendiceal tumors, part 1: Appendiceal tumors without peritoneal involvement. Ann Surg Oncol. 2025;25.
3. Mohamed A, Wu S, Hamid M, Mahipal A, Cjakrabarti S, Bajor D, Selfridge JE, Asa SL. Management of appendix neuroendocrine neoplasms: insights on the current guidelines. Cancers (Basel). 2022;15:295.
4. Shah MH, Goldner WS, Benson AB, Bergsland E, Blaszkowsky LS, Brock P, Chan J, Das S, Dickson PV, Fanta P, Giordano T, Halfdanarson TR, Halperin D, He J, Heaney A, Heslin MJ, Kandeel F, Kardan A, Khan SA, Kuvshinoff BW, Lieu C, Miller K, Pillarisetty VG, Reidy D, Salgado SA, Shaheen S, Soares HP, Soulen MC, Strosberg JR, Sussman CR, Trikalinos NA, Uboha NA, Vijayvergia N, Wong T, Lynn B, Hochstetler C. Neuroendocrine and adrenal tumors, version 2.2021, NCCN clinical practice guidelines in oncology. J Natl Compr Canc Netw. 2021;19:839-868.
5. Pavel M, Öberg K, Falconi M, Krenning EP, Sundin A, Perren A, Berruti A; ESMO Guidelines Committee. Electronic address: clinicalguidelines@esmo.org. Gastroenteropancreatic neuroendocrine neoplasms: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2020;31:844-860.
6. Moertel CG, Weiland LH, Nagorney DM, Dockerty MB. Carcinoid tumor of the appendix: treatment and prognosis. N Engl J Med. 1987;317:1699-701.
7. Brighi N, La Rosa S, Rossi G, Grillo F, Pusceddu S, Rinzivillo M, Spada F, Tafuto S, Massironi S, Faggiano A, Antonuzzo L, Santini D, Sessa F, Maragliano R, Gelsomino F, Albertelli M, Vernieri C, Panzuto F, Fazio N, De Divitiis C, Lamberti G, Colao A, Fave GD, Campana D. Morphological factors related to nodal metastases in neuroendocrine tumors of the appendix: a multicentric retrospective study. Ann Surg. 2020;271:527-533.
8. Appiah JK, Asante R, Donneyong E, Cherukuri S. Incidental Grade 2 Appendiceal neuroendocrine tumor presenting as acute appendicitis in a young adult male patient. Cureus. 2025;17:e83609.
9. Bayhan Z, Yildiz YA, Akdeniz Y, Gonullu E, Altintoprak F, Mantoglu B, Capoglu R, Kahyaoglu Akkaya Z. Appendix neuroendocrine tumor: retrospective analysis of 4026 appendectomy patients in a single center. Emerg Med Int. 2020;2020:4030527.
10. Hasan F, Davoodi A, Bordogna A, Dalwadi S, Timsaal Y, Singh A, Garcia A, HooKim K, Roy S. A case of appendiceal neuroendocrine tumor with metastatic spread in a young patient. SAGE Open Med Case Rep. 2025;13:2050313X251369764.
11. Villa M, Sforza D, Siragusa L, Guida AM, Ciancio Manuelli M, Pirozzi BM, Pocci M, Palmieri G, Grande M. A low-grade appendiceal mucinous neoplasia and neuroendocrine appendiceal collision tumor: a case report and review of the literature. Am J Case Rep. 2021;22:e927876.

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VIDEO ARTICLE

House Advancement Flap for the Treatment of Post-Hemorrhoidectomy Anal Stenosis: A Video Vignette

Ebubekir Korucuk, Kamil Erözkan, Osman Bozbıyık

Ege University Faculty of Medicine, Department of General Surgery, Division of Colorectal Surgery, İzmir, Türkiye

Keywords: House advancement flap, anal stenosis, hemorrhoidectomy complications, anoplasty

Introduction

Anal stenosis, commonly occurring as a complication of hemorrhoidectomy, is a rare condition characterized by anatomical stricture or functional narrowing of the anal canal, considerably impacting patients' quality of life.[1] Anal stenosis is categorized by the degree of narrowing into mild, moderate, or severe.[2] Management strategies differ according to severity: mild cases often respond well to conservative measures such as laxatives, dietary adjustments, and lifestyle changes, whereas moderate and severe cases typically necessitate surgical intervention.[3] House flap anoplasty has been identified as an effective approach for severe distal anal stenosis. This video presents a clinical case of anal stenosis following Ferguson hemorrhoidectomy, providing technical insights and procedural guidance.

Case Report

Here, we present the case of a 40-year-old male patient who was referred to our center with anal pain and difficulty with defecation. The symptoms developed 4 months after an extensive hemorrhoidectomy performed in a single session. On physical examination, severe anal stenosis was identified, with the anal verge measuring approximately 4-5 mm in diameter, insufficient to allow the passage of a small finger. Given the severity of the condition, surgical intervention was indicated, and informed consent was obtained for both the operation and photograph/video sharing.

The patient underwent surgical treatment under regional anesthesia in the lithotomy position. A house-shaped skin flap, measuring 3 cm along the anal margin between the 1 and 5 o'clock positions, was delineated. Following incision along the marked boundaries, an island flap was prepared while preserving its vascular integrity. The narrowing fibrotic scar was incised, and the flap was advanced into the anal canal. The flap was sutured to the anal mucosa using 3-0 polyglactin 910 sutures. A vacuum drain was placed within the flap cavity, and the external wound was closed with 2-0 polyglactin 910 sutures. After completion of the anoplasty, digital rectal examination revealed that the index finger could easily pass through the anal canal. Subsequently, an 18-mm Hegar dilator was introduced smoothly through the anal verge without resistance. The House flap anoplasty procedure was completed without intraoperative complications (Video 1).

The patient was discharged on postoperative day 2 after the removal of the vacuum drain, with no complications reported during hospitalization. At the 3-month postoperative follow-up, clinical evaluation demonstrated complete recovery. Digital rectal examination showed no evidence of recurrence or postoperative complications, and the patient reported being asymptomatic and having normal defecation. Postoperative imaging could not be obtained, as the patient resides outside of Türkiye and was subsequently lost to follow-up. However, a later telephone interview confirmed that the patient remains symptom-free and continues to live without defecatory difficulties.

Address for Correspondence: Kamil Erözkan, MD, Ege University Faculty of Medicine, Department of General Surgery, Division of Colorectal Surgery, İzmir, Türkiye
E-mail: kamil.erozkan@ege.edu.tr **ORCID ID:** orcid.org/0000-0003-2193-9984
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House flap anoplasty is a feasible and effective surgical technique for managing severe distal anal stenosis, particularly in patients who develop this condition as a complication of hemorrhoidectomy. Achieving favorable short-term outcomes in flap advancement depends on careful flap preparation, as improper flap design can hinder healing and lead to complications such as flap necrosis, dehiscence, or recurrence of stenosis.

Ethics

Ethics Informed Consent: Given the severity of the condition, surgical intervention was indicated, and informed consent was obtained for both the operation and photograph/video sharing.

Acknowledgment

This video was accepted as a video presentation for the 20th Turkish Society of Colon and Rectal Surgery (TSCRS) Congress will take place in Antalya, Türkiye from 16-20 May 2025.

Footnotes

Authorship Contributions

Surgical and Medical Practices: K.E., O.B., Concept: K.E., Design: K.E., Data Collection or Processing: E.K., Literature Search: O.B., Writing: E.K., K.E.

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REFERENCES

1. Liberman H, Thorson AG. How I do it. Anal stenosis. Am J Surg. 2000;179:325-329.
2. Milsom JW, Mazier WP. Classification and management of postsurgical anal stenosis. Surg Gynecol Obstet. 1986;163:60-64.
3. Casadesus D, Villasana LE, Diaz H, Chavez M, Sanchez IM, Martinez PP, Diaz A. Treatment of anal stenosis: a 5-year review. ANZ J Surg. 2007;77:557-559.

Video 1. https://www.youtube.com/watch?v=msQ3dHUVN4s

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