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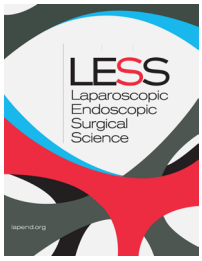

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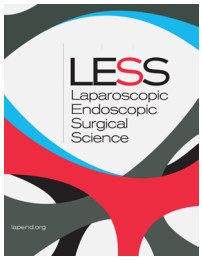

Information to Authors

Laparoscopic Endoscopic Surgical Science (LESS) is a peer-reviewed, independent, international periodical that considers for publication clinical and experimental studies, reviews, case reports, technical contributions, and letters to the editor. Scope of the journal covers the minimally invasive surgical and endoscopic interventions. It is an open access journal and published four times (March, June, September, and December) a year in English. Authors are responsible for the accuracy of data and the journal is in compliance with the uniform requirements for manuscripts submitted to biomedical journals published by the ICMJ (updated in August 2013).

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Original Article

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Real-time contrast-enhanced endoanal ultrasound vs. MRI in perianal fistula: Which modality leads to better surgical mapping?

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ABSTRACT

Introduction: Perianal fistula (PAF) is a benign anorectal disease that can seriously affect the quality of life of patients if diagnosis and treatment are delayed. In this study, we compared the diagnostic performance of Magnetic Resonance Imaging (MRI) and contrast-enhanced anal ultrasonography (EAUS), which are commonly used before surgical planning for PAF treatment.

Materials and Methods: Between 2022-2024, the records of 40 patients who underwent contrast-enhanced EAUS and MRI examinations and subsequent surgical treatment for PAF at Sakarya University Training and Research Hospital during the preoperative period were retrospectively evaluated. Using intraoperative findings as the "gold standard" reference, the sensitivity, specificity, and positive/negative predictive values of both preoperative diagnostic methods for mapping the fistula tracing, detecting the internal orifice, and identifying existing abscesses were investigated.

Results: The mean age of the patients was 41 years (19-73) and 72.5% were male (n=29). Of the 40 patients, 29 were classified as having primary (72.5%) and 11 as having recurrent perianal fistulas (27.5%). Contrast-enhanced EAUS accurately mapped the fistula tracts 85% of the time, with a success rate of 100%, especially in primary fistulas. In contrast, in the presence of recurrent disease, the diagnostic sensitivity of EAUS was insufficient in 22 patients (54.5%). EAUS was found to be advantageous in detecting submucosal or small abscesses, whereas MRI was more effective in identifying multiple and complex tracts because of its advantage of wide anatomical mapping. In addition, real-time evaluation of EAUS was found to be an important advantage in determining the relationship between the fistula tract and anal sphincter structures.

Conclusion: Contrast-enhanced EAUS and MRI are complementary modalities for the preoperative mapping of perianal fistulas. Although MRI provides superior anatomical details in the presence of complicated and recurrent disease, EAUS provides real-time evaluation, is easily reproducible, and can be used even in the operating room. The sequential or combined use of both methods, especially in the presence of complicated or recurrent disease, can significantly contribute to increasing surgical success.

Keywords: Contrast-enhanced endoanal ultrasound, magnetic resonance imaging (MRI), perianal fistula, surgical mapping

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Introduction

Benign perianal pathologies are a group of diseases commonly encountered in current surgical practice that can significantly impair patients' quality of life if left untreated. Perianal fistulas (PAF), which are benign perianal diseases that can develop in 15–38% of cases following anal abscesses, are included in this group. Treatment options include various surgical interventions.[1] Accurate diagnosis and classification of perianal fistulas are critical for determining effective treatment strategies.[2,3]

The primary imaging methods currently used in the evaluation of perianal diseases are Magnetic Resonance Imaging (MRI) and Endoanal Ultrasonography (EAUS).[4,5] Preoperative mapping performed radiologically provides the opportunity to determine the strategy for the surgical procedures that can be performed as well as allowing for changes in the surgical procedure during the intraoperative period. In this way, it is clear that performing invasive procedures with a "road map" in the complex anatomical structure of the perianal region will have a significant effect on postoperative outcomes, providing a wide range of positive results, from patient satisfaction in the postoperative recovery process to the prevention of temporary or permanent complications.[6,7]

Although there are various publications in the literature regarding the different working principles, advantages, and disadvantages of Magnetic Resonance Imaging and EAUS, studies investigating the diagnostic performance of these two methods in PAF patients are quite limited.[8] In this study, we aimed to compare the diagnostic data obtained with MRI and contrast-enhanced EAUS in the preoperative period of PAF patients with the findings detected during surgery. Thus, the contributions of both methods to the preoperative surgical strategy determination process were evaluated, and the accuracy of MRI and EAUS in the diagnosis of PAF was revealed in terms of surgical outcomes.

Materials and Methods

Study Design and Ethical Approval

This study had a retrospective single-center design. Patients diagnosed with PAF who underwent surgery at the General Surgery Clinic of Sakarya University Education and Research Hospital between 2022-2024 were included in this study. Ethical approval for the study was obtained from the Scientific Research Ethics Committee of Sakarya University (No: E-43012747-050.04-428168-163, Date: 20/11/2024). This study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Selection

The medical records of the patients diagnosed with PAF during the study period were retrospectively reviewed. Patients who had undergone medical treatment, those with fistulas associated with inflammatory bowel disease, pregnant women, those with incomplete medical records, and those who refused to participate in the study were excluded from the study.

Patients who were diagnosed with PAF during the specified period and underwent contrast-enhanced EAUS and MRI examinations before surgery, followed by surgical treatment, were evaluated in this study.

Imaging Methods

EAUS examinations were performed by two surgeons using an Arietta 65 endorectal probe (Hitachi, Japan). The rectum was emptied with a rectal enema prior to examination, which was performed in the prone position. Hydrogen peroxide (H_2O_2) was administered simultaneously with the fistula external opening during ultrasonographic evaluation using a gray-colored branule to create a contrast agent and perform mapping. EAUS was used to classify fistulas (intersphincteric, transsphincteric, suprasphincteric, extrasphincteric, or superficial). Mapping of the fistula tract(s) (trajectory, extension area, etc.), presence or location of the internal opening of the fistula, presener of accompanying abscesses, whether the fistula is a multiple-tract (branched), and the relationship of the fistula tract with the internal and external sphincters (damage, invasion, etc.) were analyzed.

Magnetic resonance (MR) examinations were performed by a radiologist using 1.5 T MR (Siemens, Germany) devices available in the institution's radiology unit. The protocol primarily used T2, T2 fat-suppressed sequences, and contrast-enhanced sequences, when deemed necessary. The same parameters used in EAUS were used in the fistula evaluation.

Surgical Evaluation

The findings obtained during surgery were considered 'reference findings.' The surgical team carefully explored the anal canal and perianal region in all cases to evaluate fistula tracts, internal orifice localization, possible additional cavities or abscesses, and sphincter integrity. The parameters reported during the operation were compared with the EAUS and MRI results and analyzed. Diagnostic consistency (agreement) analyses were performed by comparing the surgical findings with EAUS and MRI reports.

Data Collection

The dataset created for each patient was processed into a single Excel table containing the following basic variables (Table 1).

Statistical Analysis

SPSS 22 (IBM SPSS Statistics, Armonk, NY, USA) software was used for statistical analyses. Continuous variables are presented as mean±standard deviation or median (min-max), and categorical variables are presented as numbers and percentages. The agreement between EAUS and MRI with the surgical findings was evaluated by calculating the sensitivity, specificity, positive predictive value, and negative predictive value. Differences between the two methods were compared using the chi-square test or Fisher's exact test, with $p<0.05$ considered statistically significant.

Results

The information of 192 patients diagnosed with PAF within a specified period was retrospectively evaluated. After excluding 152 patients based on the exclusion criteria mentioned above, the remaining 40 patients were included in the study.

Of the patients, 29 (72.5%) were male and 11 (27.5%) were female, with a mean age of 41 years (range, 19–73 years). The mean age was 32 years (range, 19–49 years) for female patients and 44 years (range, 24–73 years) for male patients. Of the 40 patients included in the study, 29 (72.5%) were diagnosed with primary PAF, and 11 (27.5%) with re-

Table 1. Variables and definitions

Variable	Description / Unit
Patient ID	Unique patient identifier
Procedure Date	Date of ERUS/MRI examination (DD/MM/YYYY)
Sex	M: Male, F: Female
Age	Years
Diagnosis	Subtype of perianal fistula or other relevant diagnosis
IAS Diameter	Internal anal sphincter diameter (mm)
Sphincter Injury	Present / Absent
Fistula Characteristics (ERUS)	Features of the fistula as defined by ERUS
Fistula Characteristics (MRI)	Features of the fistula as defined by MRI
Fistula Location (ERUS)	Anatomical location determined by ERUS
Fistula Location (MRI)	Anatomical location determined by MRI
Fistula Type (ERUS)	Park classification of fistula based on ERUS findings
Fistula Type (MRI)	Park classification of fistula based on MRI findings
Abscess (ERUS)	Abscess present on ERUS (Present / Absent)
Abscess (MRI)	Abscess present on MRI (Present / Absent)
Fistula Length (ERUS)	Total fistula length measured by ERUS (mm)
Fistula Length (MRI)	Total fistula length measured by MRI (mm)
Surgical Findings	Intraoperative observations and descriptions
Concordance with ERUS (%)	Percentage agreement between ERUS findings and surgery
Concordance with MRI (%)	Percentage agreement between MRI findings and surgery

IAS: internal anal sphincter; ERUS: endoanal ultrasound; MRI: magnetic resonance imaging.

current PAF. Following surgical and radiological evaluation, 19 patients (47.5%) were diagnosed with simple PAF and 21 (52.5%) with complicated PAF.

The distribution of fistula types identified in the table is presented below. A comparison of endoanal ultrasound (EAUS) and magnetic resonance imaging (MRI) findings and their confirmation with surgical reference findings resulted in the following results (Table 2).

Fistula Tract Mapping

Endoanal ultrasound successfully mapped the fistula tracts in 34 of the 40 patients (85%). In all patients with primary fistulas (n=29, 29/29; 100%), fistula tracts were completely identified using EAUS. In only 5 of 11 (5/11; 45.5%) patients with recurrent PAF, mapping was possible with EAUS, whereas mapping could not be performed in 6 patients (6/11, 54.5%).

Internal Orifice Detection

In the endoanal ultrasound evaluation, the internal orifice was detected in 30 of 40 patients (75%), whereas it could not be identified in 10 patients (25%).

The rate of internal orifice detection in primary PAF patients was 86.2% (n=25/29), while in recurrent PAF patients, the same rate was 45.5% (n=5/11).

Abscess Detection

In six patients (15%), the presence of an abscess was determined during surgical examination and/or clinical follow-up, although no abscess was reported on MRI examinations; however, all of these abscesses were detected using EAUS. In one patient (2.5%), although an abscess focus was reported on MRI, the presence of this abscess could not be demonstrated using EAUS.

Table 2. Distribution of fistula types among study patients (n=40)

Fistula Type	No. of Patients	Percentage (%)
Intersphincteric	16	40.0
Transsphincteric	14	35.0
Submucosal	2	5.0
Extrasphincteric	1	2.5
Unclassified	7	17.5

Data are shown as the number of patients (%) in each fistula category. Classification was performed according to the Park et al. system. "Unclassified" denotes fistulas that did not fit standard Park categories.

Multiple (More Than One) Fistula Tract

In six patients (15%), EAUS detected multiple fistula tracts or side branches (additional tracts), but these additional tracts were not mentioned in the MRI reports. In one patient (2.5%), on the contrary, although multiple tracts were reported on MRI, EAUS determined that there was only one tract. Surgical findings confirmed the tracts detected by EAUS.

Sphincter Relationship

In 34 of the 40 patients (85%), the relationship with the sphincter (intersphincteric, transsphincteric, etc.) was clearly evaluated by EAUS. In the remaining 6 patients (15%), assessment of the sphincter-fistula relationship was not adequately performed due to granulation tissue, chronic inflammation, or technical difficulties. In one patient (2.5%), a transsphincteric fistula was identified by EAUS, while MRI classified the same fistula as an intersphincteric fistula. However, during surgical exploration, the classification was confirmed as transsphincteric fistula, and Laser Ablation of Fistula Tract (LAFT) was applied.

Recurrent Perianal Fistulas

In four of the patients in the recurrent group (n=4/11; 36%), the fistula tract and its branches could be mapped in detail with MRI, while EAUS failed to fully visualize and identify the fistula tract and its branches.

Submucosal Fistulas

In two patients (5%), submucosal abscesses were only detectable with EAUS, while these foci were not reported in the MRI findings.

Representative imaging of perianal fistula/lesion types according to the Park classification (contrast-enhanced where indicated) is shown in Figure 1, with Panels A–F illustrating the spectrum of common fistula anatomies and associated lesions.

Discussion

In this study, it was determined that both radiological methods provide important information in the preoperative period but that they have advantages and disadvan-

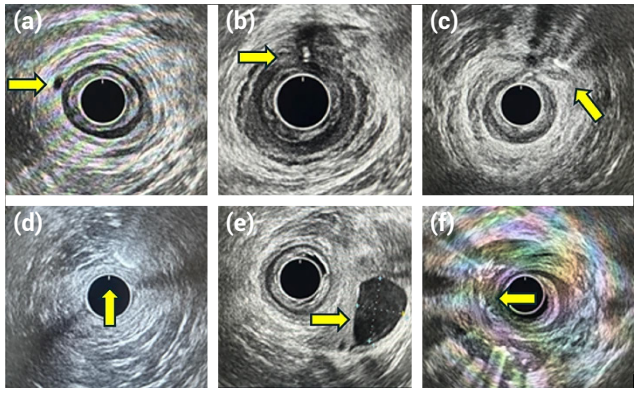

Image No	Fistula/Lesion Type	Park Classification
A	Intersphincteric fistula	Type I
B	Intersphincteric fistula with low transsphincteric extension	Type IIa (low transsphincteric)
C	High transsphincteric fistula	Type IIb (high transsphincteric)
D	Intersphincteric fistula (contrast-enhanced)	Type I
E	Perianal abscess	—
F	Intersphincteric "horseshoe" fistula	Type I (horseshoe variant)

Figure 1. Representative imaging of perianal fistula/lesion types according to Park classification. Panels A–F show the spectrum of common fistula anatomies and associated lesions as visualized on endoanal ultrasound (with contrast where indicated).

tages when compared to each other in certain subgroups of the disease. In studies comparing the two methods in the literature, it has been stated that MRI is particularly effective in complex and recurrent cases, while EAUS provides high accuracy in imaging submucosal or intersphincteric lesions.[9-12] In our study, similar to the literature, MRI provided more satisfactory preoperative examination results in patients with recurrent PAF due to its extensive anatomical mapping feature, while EAUS did not allow for adequate diagnostic evaluation in this patient group. In our study, it was observed that granulation tissue, scar tissue, or chronic inflammation that developed due to previous surgical interventions or repeated abscess drainage negatively affected the EAUS evaluation. However, the ability to perform nearly accurate evaluations with EAUS in patients with primary PAF supports our view. This leads us to conclude that EAUS examination may be sufficient on its own in the primary or simple fistula patient group, whereas MRI examination may be appropriate in more complex cases.

The ability to identify the internal orifice is important because it can influence the type and extent of surgery performed in PAF surgery. One of the most important advantages of EAUS is that it is applied in direct contact with the relevant anatomical region, thereby enabling a millimeter-level examination of the internal structure of the anal canal.[13] However, despite all efforts, it is sometimes not possible to identify the internal orifice either radiologically or surgically. This situation may arise, especially in recurrent cases, because the internal orifice is not clearly visible or deformed.[14] Consistent with these findings, in our study, the rate of detection of the internal orifice with EAUS was very high in patients with primary PAF, whereas MRI examination was found to be useful, especially in cases where EAUS was ineffective.

Another important clinical finding in patients with perianal fistulas is the presence of abscesses. The presence of an abscess correlates with aggressive clinical symptoms and the necessity of medical treatment and is considered a limiting factor for definitive surgical treatment, except in emergency situations.[14,15] Therefore, accurate determination of the presence, location, and size of an abscess is extremely important in patients scheduled for surgical treatment. Small collections at the submucosal or internal sphincter level may sometimes remain unclear on MRI sequences, particularly fat-suppressed T2 or contrast-enhanced images. Similarly, the literature reports that this issue can be partially overcome using specialized sequences such as T2 TSE SPIR, but small submucosal abscesses may not always be optimally visualized.[15,16] In our study, all patients with small abscess foci were successfully identified with EAUS, while MRI reports did not mention these abscess foci. We believe that this is due to the high-resolution close-field scanning capability of EAUS, which allows the detection of small abscesses or submucosal cavities.

Perianal fistula surgery is a type of surgery that inherently carries a certain level of risk of incontinence. Therefore, accurately determining the presence of sphincter damage or the relationship between the fistula and sphincter prior to PAF surgery is extremely important in preventing the development of anal incontinence after surgery. In our study, the rate of accurate determination of the fistula-sphincter relationship using EAUS was very high (85%). In one case, the classification determined by EAUS was different from that determined by MRI, and the EAUS classification was confirmed by surgical findings. We believe that this difference may be due to the lack of standardiza-

tion of technical parameters in the MRI protocol or differences in interpretation experience. Similarly, according to literature EAUS has high sensitivity in clarifying sphincter involvement but that combined evaluation with MRI is preferred in recurrent cases.[4,9] Especially in patients with recurrent PAF, as also found in our study, MRI examination is more advantageous in identifying additional fistula tracts or fistula tracts extending more proximally in the anatomical plane. Therefore, combined examinations using both methods will be more effective and beneficial in determining the surgeon's surgical strategy in patients with recurrent PAF.

In general, our study is consistent with the results of other studies in the literature, showing that EAUS performs better in terms of sphincter integrity, abscess presence, and submucosal involvement and has a very high diagnostic value in primary PAF patients, while MRI is superior in cases of complex/transelevator or recurrent PAF because of its advantage in providing extensive anatomical mapping. Additionally, some studies in the literature report that T2 fat-suppressed and contrast-enhanced MRI sequences may facilitate the identification of detailed pathological foci; however, they also note that certain MRI-specific disadvantages, such as cost, accessibility, motion artifacts, and radiologist dependence, may limit their use.[9,11,12,14,15]

Limitations

The findings of this study should be evaluated within the framework of the following limitations. The retrospective nature of the study and its conduct at a single center may have caused sampling bias and limited the generalizability of the results to different institutions or patient populations. The analysis of 40 patients may have limited statistical power, particularly in subgroup comparisons such as primary and recurrent fistula cases. A larger cohort would strengthen the consistency and validity of the observed differences. Endoanal ultrasound examinations were performed by two experienced surgeons, whereas MRI examinations were conducted by a radiologist. The lack of measurement of inter-observer agreement leaves uncertainty as to whether the mapping accuracy is consistent across different operators.

Conclusion

Our study has demonstrated that contrast-enhanced EAUS and MRI are complementary in preoperative mapping in patients with perianal fistulas but offer different advantages in terms of their areas of application, costs, and accessibility. In cases with complex anatomical structures or recurrent and multiple fistula tracts, MRI provides clear mapping capabilities owing to its superior anatomical details and wide-field scanning. By contrast, EAUS stands out for its real-time imaging capability, low cost, and ease of repeatability. When performed by an experienced surgeon in the operating room before or during surgery, it allows for rapid modification of the surgical strategy, as needed.

In complex or recurrent cases, the sequential or combined use of MRI and contrast-enhanced EAUS can enhance surgical success rates by combining the advantages of both methods. This approach provides reliability and flexibility in preoperative planning, and contributes to the development of patient-specific surgical strategies.

Disclosures

Ethics Committee Approval: This non-interventional retrospective study was approved by the Non-Interventional Ethics Committee of the Faculty of Medicine, Sakarya University (No. E-43012747-050.04-428168-163, Date: 20/11/2024). The requirement for written informed consent was waived by the committee due to the study's retrospective design.

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Original Article

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Comparison of Lichtenstein and TEP techniques in inguinal hernia repair: Impact of surgical experience on outcomes

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ABSTRACT

Introduction: Inguinal hernia repair is among the most frequently performed surgical procedures worldwide. Although both anterior open mesh repair (Lichtenstein) and posterior laparoscopic repair (TEP) are widely used, the impact of surgical experience and setting on perioperative outcomes remains inadequately studied. The objective is to compare the clinical outcomes of Lichtenstein and TEP techniques in inguinal hernia repair and assess the influence of surgical experience in training versus routine settings.

Materials and Methods: This retrospective cohort study included 361 patients who underwent elective inguinal hernia repair between January 2015 and June 2019. Patients were grouped based on the setting: training (residents under supervision, n=78) and routine (attending surgeons, n=283). Surgical techniques (Lichtenstein vs TEP) were compared regarding operation time, complication rates, length of hospital stay, and recurrence. Statistical analyses were performed using SPSS version 23.0 with a significance level of $p<0.05$.

Results: The mean patient age was 52.6±16.1 years, with males comprising 94.7% of the cohort. Lichtenstein repair was performed in 202 patients (56%) and TEP in 159 patients (44%). Operative time was significantly longer in the training group than in the routine group (74.3±37.5 vs 58.0±38.5 min, $p=0.001$). Complication rates were also higher in the training group ($p<0.05$). Bilateral hernia repair significantly increased operative time in both techniques. No significant differences were observed in hospital stay duration. Early and late recurrence occurred in 1.4% and 4.4% of patients, respectively, without technique-specific differences.

Conclusion: Both Lichtenstein and TEP techniques are safe and effective for inguinal hernia repair. However, outcomes are significantly influenced by the surgeon's experience and the procedural context. Structured training and careful supervision are essential to minimize complications and standardize results in surgical education environments.

Keywords: Complication, inguinal hernia, laparoscopic surgery, Lichtenstein repair, operative time, recurrence, surgical training, TEP

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Introduction

Inguinal hernia is one of the most prevalent surgical conditions worldwide, with an estimated lifetime risk of 27% in men and 3% in women.[1] Surgical intervention remains the definitive treatment for inguinal hernia, aiming to relieve symptoms and prevent complications such as incarceration and strangulation.[2] Over the years, a wide array of surgical techniques has been developed, ranging from traditional open repairs to minimally invasive laparoscopic approaches.[3]

The Lichtenstein tension-free mesh repair, introduced in the 1980s, has since become a widely accepted standard due to its simplicity, reproducibility, and relatively low recurrence rates.[4] However, the posterior approach via totally extraperitoneal (TEP) laparoscopic repair has gained popularity in recent decades, especially among specialized centers, offering advantages in terms of postoperative pain, return to daily activity, and cosmetic outcomes.[5,6]

Despite the growing body of literature, the choice between anterior and posterior approaches remains controversial, particularly when it comes to training environments versus routine surgical practice.[7] One key challenge is that laparoscopic repairs, while offering potential benefits, are technically more demanding and associated with a steeper learning curve.[8] Therefore, surgical outcomes may vary significantly depending on the experience of the surgeon and the context in which the procedure is performed.[9]

In training hospitals, less experienced surgeons or residents often perform hernia repairs under supervision, which may influence both operative time and complication rates.[10] On the other hand, procedures carried out in routine practice by experienced surgeons may yield more consistent outcomes.[11]

Numerous studies have investigated the comparative effectiveness of Lichtenstein and TEP repairs in terms of operative time, postoperative pain, recurrence rates, and complication profiles.[12,13] However, few have directly compared these two techniques across educational versus routine practice settings, which is critical for understanding the translational applicability of surgical techniques in real-world environments.[14]

Moreover, there is limited data regarding how factors such as hernia laterality (unilateral vs bilateral), patient age, and gender may influence outcomes differently based on the chosen surgical technique and context.[15] Identifying these relationships is crucial for optimizing patient selection and guiding surgical decision-making.[16]

The duration of surgery is a practical outcome measure, not only reflecting the efficiency of the technique but also influencing the risk of perioperative complications and the overall cost-effectiveness of treatment.[17] Likewise, length of hospital stay serves as an indirect indicator of recovery, complication management, and institutional resource utilization.[18]

Postoperative complications, encompassing both early events such as hematoma and infection, and late outcomes including recurrence and chronic pain, constitute critical parameters in the assessment of the safety, efficacy, and long-term durability of hernia repair techniques.[19] These outcomes are particularly important when comparing surgeries performed by residents in training versus experienced surgeons.[20]

This study aims to evaluate and compare the Lichtenstein and TEP inguinal hernia repair techniques in terms of operative time, hospital stay, complication rates, and recurrence, specifically contrasting outcomes between training and routine surgical practice. Furthermore, it seeks to identify demographic and procedural variables that may influence these outcomes.

By conducting a comprehensive analysis of these parameters, this study intends to provide valuable insights for optimizing surgical training and enhancing the overall quality of inguinal hernia management in diverse clinical settings.

Materials and Methods

Study Design and Setting

This retrospective cohort study was conducted at the General Surgery Department of a tertiary-care institution, between January 2015 and June 2019. The study protocol was approved by the Kutahya University of Health Sciences Ethics Committee prior to data collection (Approval no: 2019/9-17 Date: 28.08.2019) and conducted according to Helsinki Declaration.

Patient Selection

A total of 459 patients who underwent elective inguinal hernia repair during the study period were initially eval-

uated. Patients with incomplete medical records, missing operative data, or follow-up loss were excluded from the study. After exclusion of 98 cases due to missing or erroneous data, 361 patients were included in the final analysis.

Patients were stratified into two groups based on the surgical setting:

Training Group: Procedures performed by surgical residents under supervision (n=78).

Routine Group: Procedures performed by experienced attending surgeons (n=283).

Surgical Techniques

Two surgical techniques were evaluated:

Lichtenstein Repair: A conventional open anterior mesh repair technique using a polypropylene mesh placed over the posterior wall of the inguinal canal.

Totally Extraperitoneal Procedure (TEP): A laparoscopic posterior approach involving the placement of mesh in the preperitoneal space without breaching the peritoneum.

The choice of technique was made based on surgeon preference, anatomical considerations, and availability of laparoscopic equipment.

Data Collection

Demographic data (age, gender), hernia characteristics (laterality: Unilateral vs bilateral), surgical technique, operation time (in minutes), length of hospital stay (in days), intraoperative and postoperative complications, and recurrence (early and late) were extracted from electronic medical records and operative notes.

Complications were classified as:

Intraoperative: Including bleeding, visceral injury.

Early postoperative (within 30 days): Hematoma, seroma, wound infection.

Late complications: Chronic pain, mesh-related issues, and recurrence.

Recurrence was defined as the presence of a clinically or radiologically confirmed inguinal hernia in the previously repaired site.

Outcome Measures

The primary outcomes of the study were:

Operative time (min)

Postoperative complications (yes/no)

Length of hospital stay (days)

Early recurrence (within 30 days)

Late recurrence (after 30 days)

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and range, while categorical variables were presented as frequency and percentage.

The Shapiro-Wilk test was used to assess normality.

Student's t-test or Mann–Whitney U test was applied to compare continuous variables, depending on distribution.

Chi-square or Fisher's exact test was used for categorical comparisons.

Pearson correlation analysis was conducted to examine associations between variables such as operative technique, operation time, complications, and recurrence.

A p-value <0.05 was considered statistically significant.

Results

A total of 459 patients who underwent inguinal hernia repair between January 2015 and June 2019 were initially reviewed. After excluding 98 patients due to data inaccuracies or missing information, 361 patients were included in the final analysis (Fig. 1).

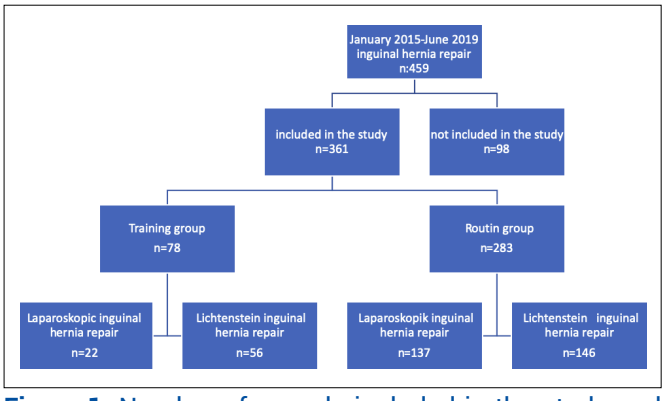

Figure 1. Number of records included in the study and analysis.

Demographic and Clinical Characteristics

The mean age of the patients was 52.6 ± 16.1 years (range: 18–88), with 77.6% of the cohort aged below 65 years. Male patients constituted 94.7% of the study population, while female patients accounted for only 5.3%. The majority of procedures were unilateral (71.7%), and bilateral repairs comprised 28.3% of cases. Regarding surgical techniques, 56% of patients underwent anterior mesh repair using the Lichtenstein technique, while 44% were treated via posterior laparoscopic repair (TEP). The mean duration of surgery was 61.5±38.8 minutes (range: 20–215), and the average length of hospital stay was 1.9±1.2 days (range: 1–10). Postoperative complications occurred in 4.7% of patients, with early recurrence observed in 1.4% and late recurrence in 4.4% (Table 1).

Distribution of Surgical Techniques

A significant difference was observed in the distribution of surgical techniques between the training and routine groups. In the training group, Lichtenstein repairs were performed in 56 cases, while TEP was applied in 22 cases. In contrast, the routine group included 146 Lichtenstein and 137 TEP procedures. This distribution is visually represented in Figure 2.

Operation Time

The mean operation time was significantly longer in the training group compared to the routine group (74.3 ± 37.5 min vs. 58.0±38.5 min, p=0.001). Among the surgical techniques, TEP was associated with a longer operative time than Lichtenstein repair across both groups (Fig. 3; Table 2). Additionally, bilateral hernia repairs had significantly longer operation durations than unilateral repairs (Lichtenstein: 112.2 vs. 58.5 min; TEP: 94.7 vs. 43.8 min; p<0.05 for both comparisons).

Table 1. General demographic and surgical characteristics in the study sample

Variable	Value
Age (years)	52.6±16.1 [18–88]
<65	280 (77.6%)
65–79	67 (18.6%)
>80	14 (3.9%)
Female / Male	19 / 342 (5.3% / 94.7%)
Elective / Emergency	78 / 283 (21.6% / 78.4%)
Unilateral / Bilateral	259 / 102 (71.7% / 28.3%)
Lichtenstein / TEPP	202 / 159 (56% / 44%)
Operation time (minutes)	61.5±38.8 [20–215]
Length of hospital stay (days)	1.9±1.2 [1–10]
Complication	17 (4.7%)
Early recurrence	5 (1.4%)
Late recurrence	16 (4.4%)

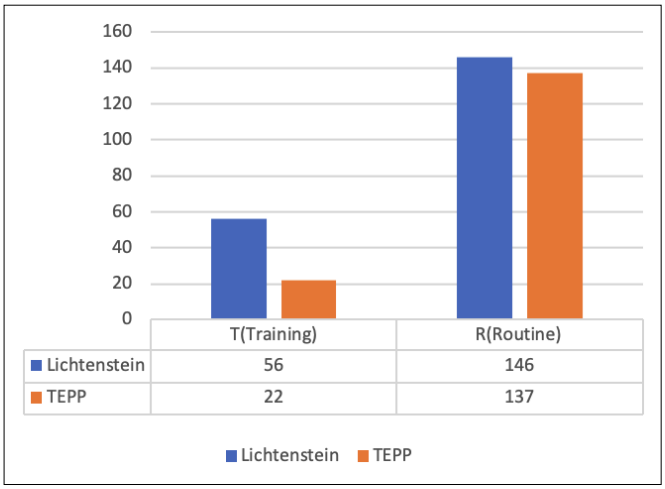

Figure 2. Graphical representation of the numerical distribution of inguinal hernia repair techniques used in the study sample.

Hospital Stay

The mean length of hospital stay did not significantly differ between surgical techniques or between the training and routine groups (p>0.05). The average duration was approximately 1.9 days for both techniques and groups. Furthermore, the type of hernia (unilateral or bilateral) had no significant impact on the length of hospital stay (Fig. 4).

Complication Rates

Postoperative complications occurred in 17 patients (4.7%). The frequency of complications did not significantly differ based on gender or age group. However,

Table 2. Comparison of the usage rates of Lichtenstein and TEPP techniques in inguinal hernia repair in study and routine groups*

	Training group	Routine	p
Operation times	74.3±37.5	58.0±38.5	0.001

*Mann Whitney U test/student t test, p<0.05.

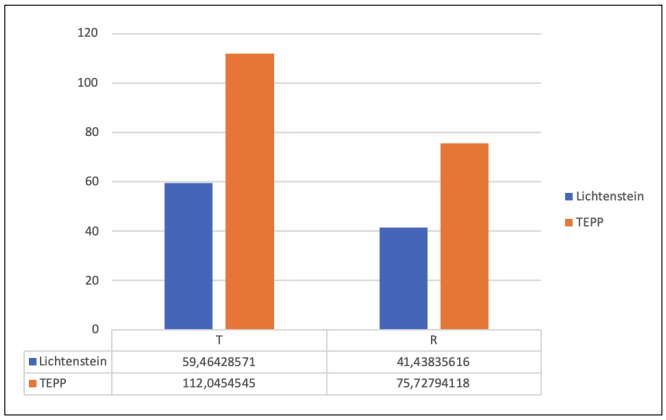

Figure 3. Graphical representation of the comparison of operative times of infguinal hernia repair techniqes in study group.

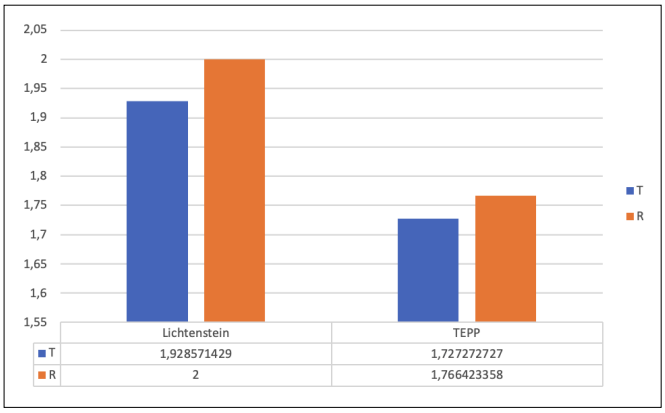

Figure 4. Graphical representation of the mean length of hospital stay after inguinal hernia repair in the study sample.

complications were more frequent in bilateral repairs compared to unilateral ones, irrespective of the surgical technique ($p<0.05$). Complication rates were also significantly higher in the training group compared to the routine group ($p<0.05$).

Recurrence Rates

Early recurrence was observed in 5 cases (1.4%), while late recurrence was seen in 16 cases (4.4%). There were no statistically significant differences in recurrence rates based on gender, age group, or surgical technique. Similarly, unilateral and bilateral repairs did not demonstrate significant differences in recurrence frequencies. However, early recurrence was significantly associated with the presence of complications ($p<0.05$), and late recurrence was associated with both complications and early recurrence ($p<0.05$).

Correlation Analyses

Pearson correlation analyses revealed that operation type (Lichtenstein vs. TEP) was significantly associated with gender, age, hernia laterality (unilateral or bilateral), and group type (training or routine) ($p<0.05$). Operation time showed a significant correlation with patient age, laterality, surgical technique, and group type ($p<0.05$). However, hospital stay was not significantly associated with any of the examined variables. Complication rates were significantly correlated with sex, group type, and operation duration, but not with age or technique. Finally, early and late recurrence were both significantly correlated with the presence of complications ($p<0.05$).

Discussion

The present study aimed to compare the outcomes of anterior (Lichtenstein) and posterior laparoscopic (TEP) inguinal hernia repair techniques in both training and routine surgical practice settings. Our findings reveal several important differences in operative time, complication rates, and recurrence, all of which have implications for surgical training and clinical decision-making.

Operative duration was significantly longer in the training group compared to the routine group, a finding that corroborates with previous studies reporting prolonged operative times among residents and junior surgeons due to inexperience and learning curve dynamics.[21] This is especially relevant in the context of laparoscopic hernia repair, which is known to require more advanced technical skills and spatial orientation than open repair techniques.[22]

Notably, TEP repairs were associated with longer operative times compared to Lichtenstein repairs across both surgical settings. This finding supports prior literature indicating that laparoscopic repairs, despite offering faster recovery, tend to be more time-consuming during the early stages of surgeon adoption.[23,24] The increased operative duration may also contribute to elevated complication rates in less experienced hands.[25]

Interestingly, bilateral hernia repairs were associated with significantly longer operation times in both techniques, confirming previous studies suggesting that bilateral involvement substantially increases surgical complexity and resource utilization.[26] However, this did not translate into significantly longer hospital stays, likely due to the application of enhanced recovery protocols.

The average hospital stay in our cohort was approximately 1.9 days, with no significant differences observed between techniques or practice settings. This aligns with enhanced recovery after surgery (ERAS) principles that have been widely adopted in elective hernia surgery to reduce length of stay and standardize discharge criteria.[27]

Postoperative complications were observed in 4.7% of patients, a rate consistent with the literature, which generally reports complication rates between 3% and 8% for inguinal hernia repairs.[28] Complication rates were higher in the training group, emphasizing the importance of experience and technical proficiency in minimizing intraoperative and early postoperative risks.[29]

Among the complications observed, bilateral procedures were again associated with higher complication rates, a finding that may be attributed to greater tissue dissection, longer surgical duration, and larger mesh placement requirements.[30] While gender and age did not significantly impact complication rates, previous studies have suggested that elderly patients, particularly those over 80, may have increased vulnerability to adverse outcomes due to comorbidities.[31]

Early recurrence occurred in 1.4% of patients, while late recurrence was observed in 4.4%, both within the expected range reported in long-term follow-up studies.[32] Importantly, recurrence rates did not significantly differ between Lichtenstein and TEP techniques, confirming the findings of recent meta-analyses that support the non-inferiority of both methods when executed with proper technique.[33,34]

Complications were significantly associated with recurrence, especially in patients experiencing early postoperative issues such as hematoma or infection. This supports previous findings indicating that early postoperative events may compromise tissue healing and mesh integration, contributing to recurrence risk.[35,36]

Our correlation analysis further demonstrated that the type of surgical technique selected is influenced not only by anatomical considerations but also by patient demographics (age, gender) and institutional context (training vs routine setting). These findings highlight the complex interplay between patient factors and surgeon decision-making.[37]

Although TEP is increasingly being promoted for its favorable long-term outcomes and patient satisfaction scores, its adoption remains limited in many institutions due to equipment costs, surgeon training demands, and operative time concerns.[38] Some studies have advocated for a tailored approach, using TEP in young, active patients or those with bilateral hernias, while reserving Lichtenstein for elderly or comorbid individuals.[39]

An important aspect of this study is its focus on educational implications. Given that complication and recurrence rates were higher in the training group, structured surgical mentorship and gradual progression from open to laparoscopic techniques are critical. Simulation-based training and supervised hands-on experience are essential to enhance competency in laparoscopic repairs.[40,41]

Moreover, our results reinforce the notion that operative time should not be the sole parameter for evaluating surgical proficiency in training. Outcomes such as complication rates, recurrence, and postoperative recovery should also be integrated into surgical performance assessments.[42]

This study contributes to the growing body of evidence supporting outcome-based evaluation of surgical training programs. Institutions should consider developing performance benchmarks and competency assessments to ensure that residents are adequately prepared for complex procedures like TEP before performing them independently.[43]

While this study offers valuable insights, it is not without limitations. Its retrospective design and single-center nature may limit generalizability. Furthermore, the lack of patient-reported outcomes, such as postoperative pain, return to work, or chronic discomfort, is a notable gap that future studies should address.[44]

Conclusion

Both Lichtenstein and TEP techniques are safe and effective options for inguinal hernia repair. However, their outcomes are significantly influenced by surgical experience and procedural context. Integrating these insights into clinical practice and surgical education is essential for optimizing patient outcomes and ensuring safe learning environments for surgical trainees.

Disclosures

Ethics Committee Approval: The study protocol was approved as a thesis by the Kutahya University of Health Sciences Ethics Committee prior to data collection (No: 2019/9-17, Date: 28/08/2019).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – M.Y.; Design – M.Y., F.Y.; Supervision – F.Y.; Funding – M.Y.; Materials – M.Y.; Data Collection – M.Y.; Analysis and/or interpretation – M.Y.; Literature Search – M.Y.; Writing – M.Y.; Critical Review – F.Y.

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Examination of pseudorecurrence cases after inguinal hernia surgery

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ABSTRACT

Introduction: Recurrence is a significant health concern following inguinal hernia surgery, and pseudo-recurrence is another significant problem among recurrence cases. This retrospective multicenter study aimed to examine pseudo-recurrence and its characteristics after laparoscopic inguinal hernia surgery.

Materials and Methods: Patients who underwent inguinal hernia surgery using the Transabdominal Preperitoneal Procedure (TAPP) and Total Extraperitoneal Procedure (TEP) procedures at various centers between 2007 and 2020 were included. Patient details, including gender, age, unilateral and bilateral sides, type of surgery, and postoperative diagnostic parameters, were obtained.

Results: Age mean of pseudo-recurrence patients was 62.58±10.34 with 32-75 range. For inguinal hernia patients, age range was 20 to 89 with 52.14±13.29 mean value. Age difference between inguinal hernia and pseudo-recurrence patients were statistically significant ($p<0.05$). All pseudo-recurrence patients were males, and 95.7% of inguinal hernia patients were males. Gender differences were insignificant as below 5% percentage ($p<0.05$). 77.0% of inguinal hernia, 78.9% of pseudo-recurrence patients had unilateral diagnosis, and differences were statistically insignificant ($p>0.05$). 8.6% of TAPP patients and 5.9% of TEPP patients were pseudo-recurrence, and differences were statistically insignificant ($p>0.05$). All pseudo-recurrence patients were males, and only 4 of patients had unilateral diagnosis. Nine patients in TAPP procedure included five aspiration hematoma, one cord lipoma, and three aspiration seroma cases. Ten patients in TEP procedure included six aspiration hematoma, three aspiration seroma and one cord lipoma. Ages were ranged from 32 to 75.

Conclusion: Pseudo-recurrence is highly prevalent in both TAPP and TEP procedures, creating unnecessary invasive procedures for patients and a significant burden on the healthcare system. Therefore, further clinical research and studies are needed to identify and treat pseudo-recurrences in inguinal hernia surgery using medical or other methods before surgery

Keywords: Inguinal hernia, pseudo-recurrence, recurrence

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Introduction

Inguinal hernias are a type of hernia that occurs in 75% of abdominal wall hernias and has a lifetime risk in 27% of men and 3% of women.[1] While risk factors vary, predisposing factors include chronic obstructive pulmonary disease, smoking, prolonged weightlifting, abdominal aortic aneurysm, appendectomy, family history, peritoneal dialysis, and prostate surgery.[2] Clinically, they are accompanied by groin pain, swelling in the area on both sides of the pubic bone, burning, and pain when coughing, and rumbling.[3] Although the etiologies of medial and lateral inguinal hernias differ somewhat, sufficient mechanistic knowledge is not yet available.[4] Treatment is generally surgical, and although laparoscopic methods are available, open surgery is also a widely preferred treatment method.[5] While open surgery allows for effective repair in patients with weak tissue or comorbidities, the laparoscopic method is preferred for patients prone to pain, athletes, bilateral patients, or those with recurrence.[6] The laparoscopic method is also preferred because it provides a quicker recovery time, minimal invasion, and pain relief.[7]

Recurrence occurs in 11% of cases after inguinal hernia surgery, and chronic pain occurs in approximately 10-12%.[8] Risk factors for recurrence include history of recurrence, surgical technique, and family history.[9] Additionally, diabetes, overweight, postoperative infection, and smoking have also been reported to increase recurrence.[10] Therefore, it is recommended that patient risk factors have a significant impact on recurrence, and the selected surgical method should be examined accordingly.[11-14] Although recurrence after inguinal hernia surgery is a significant problem, pseudo-recurrence is observed in some cases. While there are studies in the literature on inguinal hernia and recurrence, no adequate studies have been found on cases of pseudo-recurrence after inguinal hernia surgery. Therefore, this study aimed to examine pseudo-recurrence after inguinal hernia surgery and its characteristics.

Materials and Methods

Research Model

The study was designed as a retrospective, multicenter study. Data were scanned through files and analyzed using a descriptive survey model.

Patients

Patients who underwent inguinal hernia surgery at various centers between 2007 and 2020 were included. According to the power analysis conducted in this context, the aim was to obtain a total of 64 patient files with an effect size of 0.30, an 80% confidence interval, and a significance level of 0.05. Patient inclusion criteria were as follows:

- Patients who have undergone surgery by the researchers,
- Age 18 and over,
- Have undergone inguinal hernia surgery,
- Have complete patient files with relevant data,
- Have no adverse health conditions that could affect the research results

The study's exclusion criteria were:

- Those under 18 years of age,
- Those with comorbid conditions that could affect the study results,
- Those with inconsistent data in their patient files.

Patients' gender, age, unilateral bilateral side, operation type and postoperative diagnostic parameters were obtained.

Ethical Approval

The study was approved by the Memorial Clinical Research Ethics Committee (No: 61351342/020-62, Date: July 31, 2025). The study was conducted in accordance with the Helsinki Declaration and Good Clinical Practices. Due to the retrospective nature of the study, the absence of personal information, and the approval of the ethics committee, no patient consent form was used.

Statistical Methods

Operation type and side parameters were described with frequencies and differences were analyzed with Fisher's Exact test. Age parameter was described with mean, standard deviation, median and ranges. Normality of age parameter was tested with Kolmogorov Smirnov test. Since distribution was non-normal, Mann Whitney U test was used for age differences. SPSS 25.0 for windows was used for analysis at 95% Confidence Interval and 0.05 significance level.

Results

In total, 19 patients (6.9%) had pseudo-recurrence, including 9 (8.6%) TAPP and 10 (5.9%) TEPP patients, and differences were statistically insignificant (p>0.05). Age mean of pseudo-recurrence patients was 62.58±10.34 with 32-75 range. For inguinal hernia patients, age range was 20 to 89 with 52.14±13.29 mean value. Age difference between inguinal hernia and pseudo-recurrence patients were statistically significant (p<0.05). All pseudo-recurrence patients were males, and 95.7% of inguinal hernia patients were males. Gender differences were insignificant as below 5% percentage (p<0.05). 77.0% of inguinal hernia, 78.9% of pseudo-recurrence patients had unilateral diagnosis, and differences were statistically insignificant (p>0.05). 8.6% of TAPP patients and 5.9% of TEP patients were pseudo-recurrence, and differences were statistically insignificant (p>0.05) (Table 1).

All pseudo-recurrence patients were males, and only 4 of patients had unilateral diagnosis. Nine patients in TAPP procedure included five aspiration hematomas, one cord lipoma, and three aspiration seroma cases. Ten patients in TEPP procedure included six aspiration hematoma, three aspiration seroma and one cord lipoma. Ages were ranged from 32 to 75 (Table 2).

In both TAPP and TEP procedures, pseudo-recurrence patients had higher age means than inguinal hernia patients (p<0.05). In inguinal hernia patients, age mean of TEPP patients were higher. However, age mean of TEPP patients were lower in pseudo-recurrence patients (Fig. 1).

Cord lipoma patients were unilateral, and had higher age means compared to bilateral aspiration hematoma. Unilateral aspiration hematoma had highest age mean, followed by bilateral aspiration seroma and unilateral aspiration seroma (Fig. 2).

Discussion

This study investigated the rate and characteristics of pseudo-recurrence in inguinal hernia operations, and retrospectively analyzed data from two centers. The results showed that pseudo-recurrence rates were quite high in inguinal hernia operations performed using both the TAPP and TEP procedures, with reported rates of 8.6% and 5.9%, respectively.

Inguinal hernias are a type of abdominal wall hernia more common in men, commonly known as inguinal hernias or direct hernias.[1-3] While risk factors vary, the most commonly reported include gender, family history, prolonged weightlifting, peritoneal dialysis, certain lung diseases, or appendicitis surgery.[2] The underlying cause and clinical presentation are evaluated by the surgeon, and surgical treatment is provided according to the patient's condition.[5]

Table 1. Baseline characteristics of patient groups and difference analysis results

	Pseudo-recurrence		p
	No (n=256)	Yes (n=19)	
Age, mean ± SD	52.14±13.29	62.58±10.34	0.000[a]
	54.00 (20.00-89.00)	65.00 (32.00-75.00)	
Gender, n (%)		0.448[b]	
Female	11 (4.3)	-	
Male	245 (95.7)	19 (100.0)	
Side, n (%)			0.551[b]
Unilateral	197 (77.0)	15 (78.9)	
Bilateral	59 (23.0)	4 (21.1)	
Operation type, n (%)			0.268[b]
TAPP	96 (91.4)	9 (8.6)	
TEP	160 (94.1)	10 (5.9)	

[a]Mann Whitney U Test; [b]Fisher's Exact Test; SD: Standard Deviation; TAPP: Transabdominal Preperitoneal Procedure; TEP: Total Extraperitoneal Procedure.

Table 2. Pseudo-recurrence patients' age, gender and side with operation type

Gender	Age	Side	Diagnosis	Operation type
Male	68	Unilateral	Aspiration seroma	TAPP
Male	49	Unilateral	Cord lipoma	TAPP
Male	70	Unilateral	Aspiration hematoma	TAPP
Male	65	Unilateral	Aspiration seroma	TAPP
Male	69	Unilateral	Aspiration hematoma	TAPP
Male	32	Unilateral	Aspiration seroma	TAPP
Male	68	Unilateral	Aspiration hematoma	TAPP
Male	66	Unilateral	Aspiration hematoma	TAPP
Male	54	Unilateral	Aspiration hematoma	TAPP
Male	66	Bilateral	Aspiration seroma	TEP
Male	63	Unilateral	Aspiration hematoma	TEP
Male	75	Unilateral	Cord lipoma	TEP
Male	62	Unilateral	Aspiration hematoma	TEP
Male	59	Unilateral	Aspiration hematoma	TEP
Male	64	Bilateral	Aspiration seroma	TEP
Male	73	Unilateral	Aspiration hematoma	TEP
Male	50	Bilateral	Aspiration hematoma	TEP
Male	63	Unilateral	Aspiration seroma	TEP
Male	73	Bilateral	Aspiration hematoma	TEP

TAPP: Transabdominal Preperitoneal Procedure; TEP: Total Extraperitoneal Procedure.

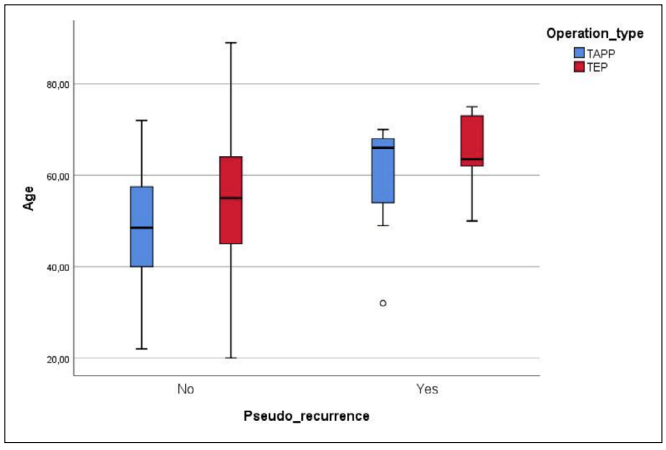

Figure 1. Age mean of patient groups according to operation procedures.

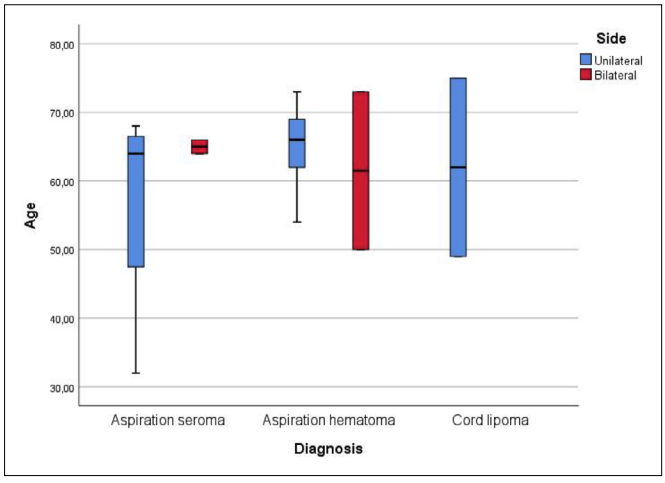

Figure 2. Age mean of patient groups according to diagnosis.

Recurrence after inguinal hernia surgery has been reported in the literature at approximately 11%,[8] and risk factors include postoperative smoking, infection, and individual and clinical characteristics.[10] Furthermore, not every case of suspected inguinal hernia recurrence is an inguinal hernia. In some cases, a false impression of recurrence can occur in suspected recurrence cases due to various reasons, such as aspiration seroma, aspiration hematoma, or cord lipoma. In these cases, it is very difficult to distinguish the difference even with the clinical presentation and the surgeon's manual examination. Consequently, inguinal hernia procedures are performed unnecessarily in a significant number of patients due to pseudo-recurrence.

Although demographic information and findings for inguinal hernia and recurrence are provided in the literature, studies on pseudo-recurrence cases are relatively limited. Among these, Tse et al.[15] examined 143 patients after laparoscopic ventral and incisional hernias and reported 10 mesh bulges, 3 seromas, and 1 retained hernia contents. Gupta et al.[16] reported 18 hematomas, 24 seromas, and 8 cord lipomas in 243 patients who underwent TEP and TAPP. Siddaiah-Subramanya et al.[17] reported that both the risk factors for inguinal hernia and recurrence are similar. However, older age and male gender appear to be risk factors for inguinal hernia recurrence.[18-23] In our study, the mean age of pseudo-recurrence patients was significantly higher. All pseudo-recurrence patients and 95.7% of inguinal hernia patients were male. 77.0% of inguinal hernia and 78.9% of pseudo-recurrence patients had unilateral diagnosis, and the differences were statistically insignificant. 8.6% of TAPP patients and 5.9% of TEP patients were pseudo-recurrence. Our results indicate that the differences between recurrence and pseudo-recurrence cases are not sufficient, either demographically or clinically, and that further differential diagnosis studies and risk factor studies are needed.

The research's contribution to the literature and surgical practice

The research's most significant contribution to the literature is its potential for significant impact on surgical practice and public health, potentially reducing healthcare burden. Furthermore, it contributes to the literature with findings that could contribute to individuals achieving a better quality of life with less invasive procedures.

The research's contribution to surgical practice is that it provides surgeons with more information about pseudo-recurrences in inguinal hernia cases, aims to reduce unnecessary surgical procedures, utilize healthcare resources effectively, and contribute to surgeons' professional well-being. Therefore, the research was designed with a pragmatic and progressive approach.

Conclusion

Pseudo-recurrence is highly prevalent in both TAPP and TEPP procedures, creating unnecessary invasive procedures for patients and a health burden for the healthcare system. However, there is a lack of sufficient research on this topic, both in practice and in the literature. Therefore, more clinical research and studies are needed to identify pseudo-recurrence cases in inguinal hernia surgeries before surgery and to treat them with medical or other methods.

Multicenter studies with larger samples, cross-comparisons, and more variables are needed to understand pseudo-recurrence rates in inguinal hernia surgeries. Although neither procedure carries a high mortality rate, it is beneficial to clarify the differences between inguinal hernia and pseudo-recurrence in terms of outcomes and public health burden.

Limitations of the Study

The most significant limitation of the study is the lack of sufficient studies in this area, making it impossible to adequately compare the results with the literature. Although studies on inguinal hernias and recurrence have been conducted, no theoretical or clinical studies on pseudo-recurrence were found.

Another limitation of the study is the limited data in the research files. Pseudo-recurrence generally requires a long period of time or the screening of a large number of patients. This is why a retrospective study was used. In retrospective studies, the control of study variables depends on the consistency and content of the data recorded in the files rather than on the researcher. However, studies with more variables, prospective studies, and longer durations may provide a better understanding of pseudo-recurrence.

Disclosures

Ethics Committee Approval: Ethical approval was obtained from the Üsküdar University Ethical Committee (Date: 31/07/2025, No: 61351342/020-62).

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Patient Consent: Not applicable due to retrospective design.

Consent for Publication: Not applicable.

Availability of Data and Materials: The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Competing Interests: None.

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Evaluation of *helicobacter pylori* prevalence in patients with bile reflux using antral and corpus biopsies

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ABSTRACT

Introduction: Alkaline reflux gastritis (ARG) is a chronic inflammatory condition caused by exposure of gastric mucosa to bile and duodenal contents. The relationship between bile reflux and *Helicobacter pylori* infection remains controversial. This study aimed to evaluate *H. pylori* prevalence and histopathological findings in patients with endoscopically detected bile reflux.

Materials and Methods: This retrospective observational study included 136 patients with bile reflux who underwent simultaneous antrum and corpus biopsies between January 2022 and January 2024. Histopathological examinations were performed using hematoxylin-eosin and modified Giemsa stains. *H. pylori* status, gastritis type, inflammation severity, activity, atrophic changes, intestinal metaplasia, and lymphoid aggregates were evaluated according to Sydney classification.

Results: *H. pylori* was positive in 76 patients (55.9%) overall, with higher prevalence in antrum (51.5%) compared to corpus (43.4%). Chronic active gastritis was significantly more common in *H. pylori* positive patients in both antrum (74.3% vs 18.2%, p<0.001) and corpus (78.0% vs 14.3%, p<0.001). Inflammation severity was significantly higher in *H. pylori* positive patients in both locations (p<0.001). Intestinal metaplasia was three times more frequent in antrum than corpus (14.7% vs 4.5%). Lymphoid aggregates were significantly more common in *H. pylori* positive patients in antrum (48.6% vs 21.2%, p<0.001).

Conclusion: Despite bile reflux presence, *H. pylori* prevalence remains high (55.9%), suggesting that endoscopically observed bile may reflect transient reflux rather than chronic alkaline reflux gastritis. The synergistic effect of *H. pylori* and bile reflux leads to more severe inflammatory changes. Histopathological confirmation is essential for alkaline reflux gastritis diagnosis, as endoscopic bile presence alone is insufficient.

Keywords: Alkaline reflux gastritis, bile reflux, chronic gastritis, duodenogastric reflux, *helicobacter pylori*, intestinal metaplasia

Introduction

Alkaline reflux gastritis (ARG) is a chronic inflammatory condition that occurs as a result of exposure of the gastric mucosa to bile and other duodenal contents.[1] This condition, which manifests with symptoms such as epigastric pain, nausea, and vomiting, is diagnosed through endoscopic and histopathological examinations.[2] However, whether the presence of bile on endoscopy alone is sufficient for the diagnosis of ARG remains a controversial topic in the literature.

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The presence of bile in the gastric lumen may not always result in mucosal damage and inflammation. In some patients, despite evident bile reflux on endoscopy, histopathological examination may reveal minimal inflammation or normal mucosal findings. This suggests that the effect of bile on the gastric mucosa may be related to individual factors, duration of exposure, and other accompanying factors.[2,3] The effect of *H. pylori* infection on ARG is not clear in the literature. Different findings have been reported regarding the effect of bile reflux on *H. pylori* infection and gastric inflammation.[4-6]

The aim of this retrospective study is to evaluate the frequency of histopathological gastritis findings and *H. pylori* prevalence in patients with endoscopically detected bile reflux. Our study investigates whether bile reflux observed on endoscopy actually leads to alkaline reflux gastritis and aims to examine the relationship between bile presence and histopathological changes.

Materials and Methods

Study Design and Patient Population

This study was designed as a retrospective observational study. Patients who underwent upper gastrointestinal endoscopy and were found to have bile reflux in the gastric lumen at the Ministry of Health Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital between January 2022 and January 2024 were included in the study.

Inclusion Criteria

- Age 18 years and above
- Presence of bile in the gastric lumen during endoscopy
- Biopsies obtained from both antrum and corpus
- Available histopathological examination results
- Complete clinical and pathological data

Exclusion Criteria

- Incomplete clinical or pathological data
- Previous gastric surgery (gastrectomy, antrectomy, gastroenterostomy, sleeve gastrectomy, etc.)
- Diagnosis of malignancy
- Patients under 18 years of age

Patient Selection and Data Collection

Patient data were collected retrospectively from the hospital information management system. A total of 311 patients with bile reflux were identified during the study period. After applying exclusion criteria, 45 patients were excluded from the study. The distribution of excluded patients was as follows:

- Patients with malignancy diagnosis (n=20): Gastric cancer (n=13), esophageal cancer (n=2), both malignancy and surgical history (n=5)
- Patients with previous gastric surgery (n=20): Total/subtotal gastrectomy (n=8), gastroenterostomy (n=8), antrectomy (n=3), sleeve gastrectomy (n=1)
- Incomplete clinical/pathological data (n=5)

After applying exclusion criteria, 266 patients with bile in the gastric lumen on endoscopy and complete histopathological evaluation results were included in the study. Of these patients, simultaneous biopsies were obtained from both corpus and antrum in 136 (51.1%).

Endoscopic Evaluation

All endoscopic procedures were performed by experienced gastroenterologists. The diagnosis of bile reflux was made based on the presence of bile in the gastric lumen during endoscopy.

Histopathological Evaluation

In 136 patients with simultaneous corpus and antrum biopsies, at least 2 biopsies were taken from each region. Biopsy specimens were fixed in 10% formalin solution and processed through routine histopathological procedures. Sections were stained with hematoxylin and eosin (H&E) and modified Giemsa stains.

Statistical Analysis

Data were analyzed using R statistical software (version 4.3.0, R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics were presented as number and percentage for categorical variables, and as mean ± standard deviation or median (interquartile range) for continuous variables. Chi-square test or Fisher's exact test was used for comparison of categorical variables, and Wilcoxon rank-sum test was used for comparison of continuous variables. P values <0.05 were considered statistically significant.

Ethical Approval

This study was approved by the Ethics Committee of Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital (Date: 12/03/2025, No: 2024/58) and conducted in accordance with the principles of the Declaration of Helsinki.

Results

Demographic and Clinical Characteristics

A total of 136 patients with bile reflux who underwent simultaneous antrum and corpus biopsies were included in the study. The median age was 49.5 (IQR: 38.0-63.0) years, with 60 (44.1%) males and 76 (55.9%) females. No significant differences were observed between *H. pylori* positive and negative groups regarding age (p=0.806) or sex distribution (p=0.120).

Smoking was present in 59 patients (43.4%), with a higher prevalence in the *H. pylori* positive group (50.0%) compared to the negative group (35.0%), though this difference was not statistically significant (p=0.080). The most common comorbidities were hypertension (42.6%), dyslipidemia (26.5%), and gastroesophageal reflux disease (22.1%). No significant differences in comorbidity distribution were found between *H. pylori* positive and negative groups (Table 1).

H. pylori Prevalence

Overall, *H. pylori* was positive in 76 patients (55.9%) and negative in 60 patients (44.1%). When analyzed by location, *H. pylori* was detected in 70 patients (51.5%) in antrum biopsies and 59 patients (43.4%) in corpus biopsies, indicating a higher colonization tendency in the antrum despite the presence of bile reflux.

Histopathological Findings in Antrum

In antrum biopsies, chronic inactive gastritis (50.0%) and chronic active gastritis (47.1%) were the most common findings. The prevalence of chronic active gastritis was significantly higher in *H. pylori* positive patients (74.3%) compared to negative patients (18.2%, p<0.001).

Inflammation was present in 94.1% of patients, with a higher rate in *H. pylori* positive (98.6%) versus negative groups (89.4%, p=0.030). According to the Sydney classification, inflammation severity showed significant differences between groups (p<0.001): Mild inflammation was more common in *H. pylori* negative patients (86.4% vs 44.9%), while moderate (39.1% vs 11.9%) and severe inflammation (15.9% vs 1.7%) were more prevalent in *H. pylori* positive patients.

Table 1. Demographic characteristics and comorbidities of patients with bile reflux

Characteristic	Overall N=136[1]	H.pylori Positive N=76[1]	H.pylori Negative N=60[1]	p[2]
Age	49.5 (38.0, 63.0)	50.0 (38.0, 63.0)	48.0 (39.0, 63.5)	0.806
Sex, n (%)				0.120
Male	60 (44.1)	38 (50.0)	22 (36.7)	
Female	76 (55.9)	38 (50.0)	38 (63.3)	
Smoking, n (%)	59 (43.4)	38 (50.0)	21 (35.0)	0.080
Diabetes mellitus, n (%)	21 (15.4)	12 (15.8)	9 (15.0)	0.899
Hypertension, n (%)	58 (42.6)	31 (40.8)	27 (45.0)	0.622
Chronic arterial disease, n (%)	9 (6.6)	5 (6.6)	4 (6.7)	>0.999
Chronic pulmonary disease, n (%)	4 (2.9)	3 (3.9)	1 (1.7)	0.630
Dyslipidemia, n (%)	36 (26.5)	17 (22.4)	19 (31.7)	0.222
GERD, n (%)	30 (22.1)	16 (21.1)	14 (23.3)	0.750
Cholelithiasis, n (%)	11 (8.1)	7 (9.2)	4 (6.7)	0.755
CKD, n (%)	14 (10.3)	7 (9.2)	7 (11.7)	0.640
Other comorbidities, n (%)	58 (42.6)	31 (40.8)	27 (45.0)	0.622

[1]Median (IQR); n (%) [2]Wilcoxon rank sum test; Pearson's chi-square test; Fisher's exact test GERD, Gastroesophageal reflux disease; CKD, Chronic kidney disease; H. pylori, Helicobacter pylori.

Activity (neutrophil infiltration) was present in 74.3% of *H. pylori* positive patients compared to 18.2% of negative patients (p<0.001). Intestinal metaplasia was observed in 14.7% of patients with no significant difference between groups (p=0.531). Atrophic changes were found in 6.6% of patients. Lymphoid aggregates/follicles were significantly more common in *H. pylori* positive patients (48.6% vs 21.2%, p<0.001) (Table 2).

Histopathological Findings in Corpus

In corpus biopsies, chronic inactive gastritis (48.5%) and chronic active gastritis (41.9%) were the predominant findings. Chronic active gastritis was significantly more frequent in *H. pylori* positive patients (78.0% vs 14.3%, p<0.001).

Inflammation was present in 90.4% of patients, with higher rates in *H. pylori* positive (98.3%) compared to negative groups (84.4%, p=0.006). Inflammation severity according to Sydney classification showed significant differences (p<0.001): Mild inflammation was predominant in *H. pylori* negative patients (87.7% vs 55.2%), while moderate (31.0% vs 9.2%) and severe inflammation (13.8% vs 3.1%) were more common in *H. pylori* positive patients.

Activity was present in 81.4% of *H. pylori* positive patients versus 13.0% of negative patients (p<0.001). Intestinal metaplasia was markedly less frequent in corpus compared to antrum (4.5% vs 14.7%) with no significant difference between *H. pylori* groups (p=0.694). Atrophic

Table 2. Histopathological findings in antrum biopsies according to h. pylori status

Characteristic	Overall N=136[1]	H.pylori Positive N=70[1]	H.pylori Negative N=66[1]	p[2]
Type of gastritis, n (%)				<0.001
Chronic active gastritis	64 (47.1)	52 (74.3)	12 (18.2)	
Chronic atrophic gastritis	0 (0.0)	0 (0.0)	0 (0.0)	
Chronic inactive gastritis	68 (50.0)	18 (25.7)	50 (75.8)	
Normal mucosa	4 (2.9)	0 (0.0)	4 (6.1)	
Activity, n (%)				<0.001
0	72 (52.9)	18 (25.7)	54 (81.8)	
1	29 (21.3)	21 (30.0)	8 (12.1)	
2	29 (21.3)	25 (35.7)	4 (6.1)	
3	6 (4.5)	6 (8.6)	0 (0.0)	
Inflammation, n (%)	128 (94.1)	69 (98.6)	59 (89.4)	0.030
Inflammation severity, n (%)				<0.001
Mild	82 (64.1)	31 (44.9)	51 (86.4)	
Moderate	34 (26.5)	27 (39.1)	7 (11.9)	
Severe	12 (9.4)	11 (15.9)	1 (1.7)	
Atrophic changes, n (%)	9 (6.6)	7 (10.0)	2 (3.0)	0.167
Atrophic changes severity, n (%)				0.250
Mild	6 (66.7)	5 (71.4)	1 (50.0)	
Moderate	2 (22.2)	2 (28.6)	0 (0.0)	
Severe	1 (11.1)	0 (0.0)	1 (50.0)	
Intestinal metaplasia, n (%)	20 (14.7)	9 (12.9)	11 (16.7)	0.531
Intestinal metaplasia severity, n (%)				0.160
Mild	12 (60.0)	4 (44.4)	8 (72.7)	
Moderate	7 (35.0)	5 (55.6)	2 (18.2)	
Severe	1 (5.0)	0 (0.0)	1 (9.1)	
Lymphoid Aggregates/Follicles, n (%)	48 (35.3)	34 (48.6)	14 (21.2)	<0.001

[1]n (%); [2]Fisher's exact test; Pearson's Chi-squared test.

changes were rare (2.9%) and found only in *H. pylori* negative patients. Lymphoid aggregates/follicles were present in 27.9% of patients with no significant difference between groups (p=0.843) (Table 3).

Comparison of Antrum and Corpus Findings

When comparing antrum and corpus findings, intestinal metaplasia was three times more frequent in antrum than corpus (14.7% vs 4.5%). Similarly, lymphoid aggregates/follicles were more common in antrum (35.3% vs 27.9%). Both locations showed strong associations between *H. pylori* positivity and chronic active gastritis, inflammation presence and severity.

Endoscopic Findings

Endoscopic findings were relatively uncommon: Antral polyps in 1.5%, corpus polyps in 1.5%, cardia/fundus polyps in 2.2%, and submucosal lesions in 2.9% of patients. No significant differences were observed between *H. pylori* positive and negative groups for any endoscopic findings (Table 4).

Discussion

Helicobacter pylori is a global health problem, affecting a significant portion of the world's population and playing a central role in the pathogenesis of gastroduodenal dis-

Table 3. Histopathological findings in corpus biopsies according to h. pylori status

Characteristic	Overall N=136[1]	H.pylori positive N=59[1]	H.pylori negative N=77[1]	p[2]
Type of gastritis, n (%)				<0.001
Chronic active gastritis	57 (41.9)	46 (78.0)	11 (14.3)	
Chronic inactive gastritis	66 (48.5)	13 (22.0)	53 (68.8)	
Normal mucosa	12 (8.8)	0 (0.0)	12 (15.6)	
Chronic atrophic gastritis	1 (0.7)	0 (0.0)	1 (1.3)	
Activity, n (%)				<0.001
0	78 (57.4)	13 (22.0)	65 (84.4)	
1	38 (27.9)	29 (49.2)	9 (11.7)	
2	15 (11.0)	13 (22.0)	2 (2.6)	
3	5 (3.7)	4 (6.8)	1 (1.3)	
Inflammation, n (%)	123 (90.4)	58 (98.3)	65 (84.4)	0.006
Inflammation severity, n (%)				<0.001
Mild	89 (72.4)	32 (55.2)	57 (87.7)	
Moderate	24 (19.5)	18 (31.0)	6 (9.2)	
Severe	10 (8.1)	8 (13.8)	2 (3.1)	
Atrophic changes, n (%)	4 (2.9)	0 (0.0)	4 (5.2)	0.133
Atrophic changes severity, n (%)				>0.999
Mild	2 (50.0)	0 (NA)	2 (50.0)	
Moderate	1 (25)	0 (NA)	1 (25.0)	
Severe	1 (25)	0 (NA)	1 (25.0)	
Intestinal metaplasia, n (%)	6 (4.5)	2 (3.4)	4 (5.3)	0.694
Intestinal metaplasia severity, n (%)				0.333
Mild	5 (83.3)	1 (50.0)	4 (100.0)	
Moderate	1 (16.7)	1 (50.0)	0 (0.0)	
Severe	0 (0.0)	0 (0.0)	0 (0.0)	
Lymphoid Aggregates/Follicles, n (%)	38 (27.9)	17 (28.8)	21 (27.3)	0.843

[1]n (%); [2]Fisher's exact test; Pearson's Chi-squared test.

Table 4. Endoscopic findings according to h. pylori status

Characteristic	Overall N=136[1]	H.pylori positive N=70[1]	H.pylori negative N=66[1]	p[2]
Antral polyp, n (%)	2 (1.5)	1 (1.3)	1 (1.7)	>0.999
Corpus polyp, n (%)	2 (1.5)	2 (2.6)	0 (0.0)	0.503
Cardia or Fundus polyp, n (%)	3 (2.2)	1 (1.3)	2 (3.3)	0.583
Submucosal Lesion, n (%)	4 (2.9)	4 (5.3)	0 (0.0)	0.130

eases.[7] *H. pylori* eradication is critical in the treatment of peptic ulcer disease and in reducing the risk of developing gastric cancer and MALT lymphoma.[8] Therefore, understanding the prevalence and colonization patterns of *H. pylori* in different clinical conditions is important.

In our study, *H. pylori* was positive in 76 (55.9%) of 136 patients with bile reflux. *H. pylori* positivity was detected in 70 patients (51.5%) in antrum biopsies and 59 patients (43.4%) in corpus biopsies. Notably, 6 patients were *H. pylori* positive in the corpus while negative in the antrum. This finding confirms that the combined biopsy protocol increases diagnostic success.[9]

One of the most important findings of our study is that the presence of bile in the gastric lumen on endoscopy is not equivalent to alkaline reflux gastritis. The detection of histopathologically normal mucosa in some patients with endoscopic bile reflux suggests that transient bile presence may not be sufficient to cause mucosal damage. This indicates that chronic exposure to bile, duration of direct mucosal contact, or differences in bile composition may be determinants in the development of mucosal damage.

The significantly high rate of chronic active gastritis in *H. pylori* positive patients in both the antrum (74.3%) and corpus (78.0%) demonstrates that *H. pylori* remains the main determinant of gastric inflammation even in the presence of bile. *H. pylori* and duodenogastric reflux cause synergistic damage to the gastric mucosa.[10] The significantly higher severe inflammation in both the antrum and corpus in *H. pylori* positive patients confirms this synergistic effect. These findings suggest that inflammatory processes in gastrointestinal diseases require more detailed investigation.[11]

Conflicting results have been reported in the literature regarding bile reflux inhibiting *H. pylori* colonization.[12,13] Our prevalence of 55.9% suggests that endoscopically observed bile may reflect transient reflux, which may be different from chronic alkaline reflux gastritis. Gastric pH changes may also affect *H. pylori* colonization.[14]

The three-fold higher prevalence of intestinal metaplasia in the antrum (14.7%) compared to the corpus (4.5%) is an important finding. Literature reports that primary bile reflux gastritis has different characteristics from *H. pylori* gastritis, but their coexistence leads to more severe premalignant changes.[15] The association of bile reflux with gastric cancer and precancerous lesions has been demonstrated, and the risk of intestinal metaplasia has been found to increase in alkaline reflux developing after cholecystectomy.[16,17] In light of these findings, our higher intestinal metaplasia rate in the antrum suggests that this region is more sensitive to both *H. pylori* and bile exposure. Risk factors and prediction models developed for endoscopic bile reflux may help determine which patients require closer follow-up.[18]

The complex effects of bile reflux on gastric microbiota are important. Hua et al.[19] showed that *H. pylori* infection reduces gastric microbial diversity and that close relationships develop between Helicobacter and non-Helicobacter bacteria, especially in patients with chronic atrophic gastritis. Additionally, bile reflux has been reported to increase gastric colonization of oral bacteria (Neisseria, Staphylococcus). These complex microbiological interactions may explain the high *H. pylori* prevalence in our study.

This study has several limitations. Due to its retrospective design, the degree, duration, and symptom severity of bile reflux could not be evaluated. The inability to perform quantitative measurement of bile reflux and the subjective nature of endoscopic evaluation are other limitations. Including only patients with simultaneous antrum and corpus biopsies limited our sample size but ensured reliable comparison. Only histopathological methods were used for *H. pylori* diagnosis; additional methods such as PCR or urea breath test were not applied.

Conclusion

In conclusion, *H. pylori* prevalence is high in patients with bile reflux. The presence of bile in the gastric lumen on endoscopy alone is not sufficient for the diagnosis of alkaline reflux gastritis; histopathological confirmation is required. Considering the synergistic effect of *H. pylori* and bile reflux, biopsies should be obtained from both antrum and corpus, *H. pylori* eradication should be performed when positive, and close surveillance should be implemented in patients with intestinal metaplasia.

Disclosures

Ethics Committee Approval: This study was approved by the Ethics Committee of Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital (Date: 12/03/2025, No: 2024/58).

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The effect of laparoscopy on the development of major complications in surgery of high-risk colorectal cancer patients

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ABSTRACT

Introduction: There are conflicting results in studies regarding the effect of laparoscopic surgery on postoperative complications in colorectal cancer patients. This study aims to evaluate the effect of laparoscopic surgery on major complications in patients undergoing surgery for colorectal cancer.

Materials and Methods: A retrospective review was conducted on 370 patients who underwent oncologic surgery for colorectal cancer at Kartal Koşuyolu High Specialization Hospital between 2013 and 2022. Patients with missing data were excluded, and a total of 257 patients were included in the study. Patients were divided into two groups based on the development of major or no complications, and clinical and pathological data were compared. The relationship between surgical method (laparoscopic vs. conventional) and complications was evaluated using multivariate Cox regression analysis.

Results: Major complications occurred in 106 of the 257 patients included in the study. The rate of major complications was found to be significantly lower in patients who underwent laparoscopic surgery (12.2% vs. 30.4%; p<0.001). In univariate analysis, conventional surgery (OR: 3.134; p<0.001), high body mass index (p=0.046), and history of Chronic Obstructive Pulmonary Disease/asthma (p=0.046) were found to be associated with major complications. In multivariate analysis, only conventional surgery was identified as an independent risk factor (OR: 2.969; p=0.002).

Conclusion: Laparoscopic surgery significantly reduces the risk of major complications in patients with colorectal cancer and can be considered a safe and effective surgical option, even in patient populations with high comorbidities.

Keywords: Clavien-Dindo classification, colorectal cancer, laparoscopic colorectal surgery, postoperative complications

Introduction

Colorectal cancer ranks as the third most common cancer globally. Advances in screening and treatment have led to steadily improving patient survival.[1] The adoption of mesocolic and mesorectal excisions via embryological plane dissection has demonstrated that survival depends not only on disease stage but also on the quality of surgical resection.[2,3]

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Since its introduction in the 1990s, laparoscopy has become integral to surgical practice, offering significant benefits such as enhanced recovery, minimal scarring, and reduced convalescence due to its minimally invasive nature. Although initially met with skepticism regarding oncological adequacy, laparoscopic surgery has now emerged as the gold standard for numerous oncological resections.[4]

The expanding role of laparoscopy has prompted extensive research into its prognostic impact and applicability. Notably, postoperative complications can delay adjuvant therapy in patients with locally advanced disease, adversely affecting survival.[5] A study by Santacruz et al.[6] demonstrated that laparoscopic procedures are less likely to cause Clavien-Dindo classification grade 3-4 complications in colon cancer patients. Initially viewed with caution, laparoscopy has proven comparable to open surgery in applicability and oncological outcomes, with growing evidence supporting its superior safety profile in terms of morbidity.[6-9]

However, as our institution is a tertiary cardiac referral center, the safety of laparoscopic colorectal surgery within a patient population characterized by high comorbidity burdens remains underexplored in the literature. This study aimed to evaluate the impact of the surgical approach on major complications in patients undergoing colorectal cancer resection at our center and to determine the safer technique for this high-risk cohort.

Materials and Methods

Study Population and Design

We conducted a retrospective analysis of 370 patients who underwent oncologic surgery for colorectal cancer at the Gastroenterology Surgery Clinic of Kartal Koşuyolu High Specialization Hospital between January 1, 2013, and December 31, 2022. All procedures were performed by board-certified surgeons with a minimum of five years of specialization. Adherence to oncological principles was maintained, with total mesorectal excision (TME) or complete mesocolic excision (CME) achieving R0 resection constituting the standard surgical technique.[3] The choice between laparoscopy and open surgery was influenced by patient factors and surgeon experience; open surgery was often preferred for ASA IV patients with high anesthetic risk due to previous abdominal surgeries or significant comorbidities.

Exclusion criteria encompassed emergency surgery (n=16), palliative procedures (n=22), R2 resections (n=14), patients undergoing HIPEC for peritoneal carcinomatosis (n=12), and those with incomplete preoperative, perioperative, pathological, or follow-up data (n=49). Consequently, 257 patients were included in the final analysis.

Inclusion Criteria

a) Patients undergoing elective surgery for histologically confirmed colon or rectal adenocarcinoma.

b) Patients who underwent R0 resection following oncological principles (TME/CME).

c) Availability of complete follow-up data and clinicopathological records.

d) Age 18 years or older.

Exclusion criteria:

a) Patients undergoing palliative or emergency surgery

b) Patients with inadequate oncological principles, such as positive surgical margins in pathology data or R2 resection

c) Patients with missing preoperative data, perioperative findings, pathological data, neoadjuvant treatment protocols, and postoperative follow-up data

d) Age under 18 years

Data Collection

Patient-related variables included age, gender, body mass index (BMI), and American Society of Anesthesiologists (ASA) score. Preoperative carcinoembryonic antigen (CEA) and CA 19-9 levels were retrieved from medical records. Tumor characteristics included location, size, differentiation, pT/pN stage, TNM stage (UICC-AJCC 8th edition),[10] lymphovascular invasion (LVI), and perineural invasion (PNI). Comorbidity data were obtained from anesthesia forms and discharge summaries.

Postoperative complications were graded according to the Clavien-Dindo classification,[11] with major complications defined as Grade III or higher. Data on complications, intensive care unit (ICU) admission, and length of stay were extracted from hospital records.

Statistical Analysis

Statistical analyses were performed using IBM® SPSS® Statistics version 25 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed with the Kolmogorov-Smirnov test. Categorical variables are presented as frequencies and percentages, and continuous variables as means ± standard deviation (SD). Group comparisons utilized the chi-square test for categorical variables and the independent t-test for continuous variables. Multivariate logistic regression analysis was employed to identify independent risk factors for major complications. A p-value <0.05 was considered statistically significant.

Ethical Approval

The study protocol received approval from the Institutional Research and Ethics Committee of the Health Sciences University Koşuyolu High Specialization Hospital (Date: 03/09/2024; No: 2024/15/902) and conducted according to Helsinki Declaration.

Results

Major complications occurred in 106 (41.2%) of the 257 patients. Comparative analysis revealed a significantly higher prevalence of asthma/COPD history in the major complication group (16.9% vs. 8.6%; p=0.042). The laparoscopic approach was less frequently utilized in patients who experienced major complications (12.2% vs. 30.4%; p<0.001). BMI was also higher in the major complication group (28.35±5.02 vs. 26.80±3.75; p=0.048). Other parameters showed no significant differences (p>0.05) (Table 1).

Comparison based on surgical approach demonstrated that ostomy formation was more common in the conventional surgery group (30.8% vs. 13.5%; p=0.009). Similarly, metastatic (M1) disease (9.5% vs. 1.6%; p=0.047) and receipt of neoadjuvant therapy (25.2% vs. 12.2%; p=0.030) were more prevalent in the conventional group. Surgical site infection (SSI) rates were significantly higher after conventional surgery (29.2% vs. 8.4%; p<0.001). Operative time was longer in the laparoscopic group (250±59 min vs. 213±69 min; p=0.024). Other variables were similarly distributed between the groups (p>0.05) (Table 2).

Univariate analysis identified conventional surgery (OR: 3.134, p<0.001), higher BMI (OR: 1.055, p=0.046), and a history of COPD/Asthma (OR: 2.171, p=0.046) as significant risk factors for major complications. These significant variables were included in a multivariate Cox regression model, which confirmed conventional surgery as an independent risk factor for major complications (OR: 2.969, 95% CI: 1.497-5.890; p=0.002). Higher BMI (OR: 1.037, p=0.194) and COPD/Asthma history (OR: 2.002, p=0.086) were not independent risk factors in the multivariate analysis (Table 3).

Discussion

This single-center retrospective study provides valuable insights into the comparative outcomes of laparoscopic versus conventional open surgery for colorectal cancer in a high-risk patient population treated at a tertiary cardiac referral center. Our findings demonstrate that laparoscopic surgery is associated with a significantly lower risk of major complications compared to open surgery, even after adjusting for potential confounders. Multivariate analysis confirmed conventional surgery as an independent predictor of major morbidity (OR: 2.969; p=0.002), underscoring the potential benefits of minimally invasive approaches in this challenging patient population.

The elevated overall rate of major complications (41.2%) in our cohort likely reflects the complex nature of our patient population, characterized by advanced age and significant comorbidities. This observation aligns with previous studies demonstrating increased surgical risk in patients with multiple comorbidities.[12] Importantly, despite this high-risk profile, laparoscopic approach emerged as a protective factor, consistent with growing evidence supporting the safety and efficacy of minimally invasive techniques in complex surgical populations.

Our results contribute to the substantial body of literature establishing laparoscopic colorectal surgery as a standard of care. Multiple randomized controlled trials and meta-analyses have demonstrated the non-inferiority of laparoscopic approaches regarding oncological outcomes while highlighting advantages in short-term recovery.[8,9,13] The landmark COST trial established the oncological safety of laparoscopy for colon cancer,[14] while more recent studies have extended these findings to rectal cancer surgery.[15] Our study strengthens this evidence base by specifically addressing outcomes in a high-comorbidity population, an area where comparative data remain limited.

Table 1. Effects of patient demographic and clinicopathological variables on the development of major complications

	Complications Absent (n:151)	Complications Present (n:106)	p†
Gender			
Male	83 (54.9%)	64 (60.3%)	0.388
Female	68 (45.0%)	42 (39.6%)	
ASA Score			
ASA I	8 (5.2%)	4 (3.7%)	0.054
ASA II	55 (36.4%)	33 (31.1%)	
ASA III	85 (56.2%)	59 (55.6%)	
ASA IV	3 (1.9%)	10 (9.4%)	
Hypertension			
No	81 (53.6%)	48 (45.2%)	0.187
Yes	70 (46.3%)	58 (54.7%)	
Coronary Artery Disease			
No	144 (95.3%)	101 (95.2%)	0.976
Yes	7 (4.6%)	5 (4.7%)	
Diabetes			
No	119 (78.8%)	73 (68.8%)	0.071
Yes	32 (21.1%)	33 (31.1%)	
COPD / Asthma			
No	138 (91.3%)	88 (83.0%)	0.042*
Yes	13 (8.6%)	18 (16.9%)	
Smoking			
No	107 (70.8%)	79 (74.5%)	0.517
Yes	44 (29.1%)	27 (25.4%)	
Localization			
Caecum	19 (12.5%)	11 (10.3%)	0.981
Ascending Colon	25 (16.5%)	19 (17.9%)	
Transverse Colon	5 (3.3%)	3 (2.8%)	
Descending Colon	14 (9.2%)	8 (7.5%)	
Sigmoid Colon	34 (22.5%)	24 (22.6%)	
Rectum	54 (35.7%)	41 (38.6%)	
Surgery			
Right Hemicolectomy	45 (29.8%)	29 (27.3%)	0.673
Extended Right Hemicolectomy	0 (0.0%)	2 (1.8%)	
Transverse Colectomy	2 (1.3%)	1 (0.9%)	
Left Hemicolectomy	14 (9.2%)	7 (6.6%)	
Anterior Resection	32 (21.1%)	21 (19.8%)	
Low Anterior Resection	45 (29.8%)	37 (34.9%)	
Abdominoperineal Resection	8 (5.2%)	6 (5.6%)	
Subtotal Colectomy	3 (1.9%)	3 (2.8%)	
Total Colectomy	2 (1.3%)	0 (0.0%)	
Ostomy			
No	116 (76.8%)	72 (67.9%)	0.113
Yes	35 (23.1%)	34 (32%)	

Table 1. Cont.

	Complications Absent (n:151)	Complications Present (n:106)	p†
Stage			
I	27 (17.8%)	11 (10.3%)	0.375
II	60 (39.7%)	49 (46.2%)	
III	53 (35.0%)	37 (34.9%)	
IV	11 (7.2%)	9 (8.4%)	
T Stage			
T1	12 (7.9%)	4 (3.7%)	0.233
T2	24 (15.8%)	11 (10.3%)	
T3	95 (62.9%)	72 (67.9%)	
T4	20 (13.2%)	19 (17.9%)	
N Stage			
N0	88 (58.2%)	63 (58.8%)	0.795
N1	42 (27.8%)	26 (24.5%)	
N2	21 (13.9%)	17 (16.0%)	
M Stage			
M0	140 (92.7%)	97 (91.5%)	0.722
M1	11 (7.2%)	9 (8.4%)	
Neoadjuvant			
No	123 (81.4%)	77 (72.6%)	0.094
Yes	28 (18.5%)	29 (27.3%)	
PNI			
No	113 (74.8%)	80 (75.4%)	0.907
Yes	38 (25.1%)	26 (24.5%)	
LVI			
No	97 (64.2%)	78 (73.5%)	0.114
Yes	54 (35.7%)	28 (26.4%)	
Grade			
Well	24 (15.8%)	14 (13.2%)	0.716
Moderate	111 (73.5%)	78 (75.4%)	
Poor	16 (10.5%)	14 (13.2%)	
Laparoscopy			
No	105 (69.5%)	93 (87.7%)	<0.001***
Yes	46 (30.4%)	13 (12.2%)	
	Mean±SD	**p‡**	
Age	61±12	63±13	0.929
BMI	26.80±3.75	28.35±5.02	0.048*
CEA	8.63±20.08	16.05±103.16	0.099
CA19.9	47.25±308.68	13.12±17.23	0.063
CA125	14.75±17.00	14.93±23.25	0.338
Operation Time (minutes)	220±65	223±72	0.288

ASA: American Society of Anesthesiology; COPD: Chronic Obstructive Pulmonary Disease; PNI: Perineural Invasion; LVI: Lymphovascular Invasion; BMI: Body Mass Index; CEA Chorioambryonic Antigen; CA: Cancer Antigen IQR: Inter Quartile Range; * p<0.05, **p<0.01, ***p<0.001; †: Chi-Square; ‡: Independent T Test.

Table 2. Patient demographic and clinicopathologic variables according to surgery type

	Conventional (n=198)	Laparoscopy (n=59)	p†
Gender			
Male	115 (58.0%)	32 (54.2%)	0.600
Female	83 (41.9%)	27 (45.7%)	
ASA Score			
ASA I	9 (4.54%)	3 ((5.08%)	0.246
ASA II	66 (33.3%)	22 (37.2%)	
ASA III	110 (55.5%)	34 (57.6%)	
ASA IV	13 (6.56%)	0 (0.0)	
Hypertension			
No	94 (47.4%)	35 (59.3%)	0.110
Yes	104 (52.5%)	24 (40.6%)	
Coronary Artery Disease			
No	172 (86.8%)	56 (94.9%)	0.086
Yes	26 (13.1%)	3 (5.08)	
Diabetes			
No	141 (71.2%)	51 (86.4%)	0.018
Yes	57 (28.7%)	8 (13.5%)	
COPD / Asthma			
No	173 (87.3%)	53 (89.8%)	0.611
Yes	25 (12.6%)	6 (10.1%)	
Smoking			
No	143 (72.2%)	43 (72.8%)	0.921
Yes	55 (27.7%)	16 (27.1%)	
Localization			
Caecum	23 (11.6%)	7 (11.8%)	0.091
Ascending Colon	32 (16.1%)	12 (20.3%)	
Transverse Colon	8 (4.0%)	0 (0.0%)	
Descending Colon	18 (9.0%)	4 (6.7%)	
Sigmoid Colon	38 (19.1%)	20 (33.8%)	
Rectum	79 (39.8%)	16 (27.1%)	
Surgery			
Right Hemicolectomy	55 (27.7%)	19 (32.2%)	0.108
Extended Right Hemicolectomy	2 (1.0%)	0 (0.0%)	
Transverse Colectomy	3 (1.5%)	0 (0.0%)	
Left Hemicolectomy	17 (8.5%)	4 (6.77%)	
Anterior Resection	33 (16.6%)	20 (33.8%)	
Low Anterior Resection	68 (34.3%)	14 (23.7%)	
Abdominoperineal Resection	12 (6.0%)	2 (3.3%)	
Subtotal Colectomy	6 (3.0%)	0 (0.0%)	
Total Colectomy	2 (1.0%)	0 (0.0%)	
Ostomy			
No	137 (69.1%)	51 (86.4%)	0.009**
Yes	61 (30.8%)	8 (13.5%)	

Table 2. Cont.

	Conventional (n=198)	Laparoscopy (n=59)	p†
Stage			
I	29 (14.6%)	9 (15.2%)	0.256
II	83 (41.9%)	26 (44.0%)	
III	67 (33.8%)	23 (38.9%)	
IV	19 (9.5%)	1 (1.6%)	
T Stage			
T1	12 (6%)	4 (6.7%)	0.969
T2	26 (13.1%)	9 (15.2%)	
T3	130 (65.6%)	37 (64.7%)	
T4	30 (15.1%)	9 (25.2%)	
N Stage			
N0	118 (59.5%)	33 (55.9%)	0.836
N1	52 (26.2%)	16 (27.1%)	
N2	28 (14.1%)	10 (16.9%)	
M Stage			
M0	179 (90.4%)	58 (98.3%)	0.047*
M1	19 (9.5%)	1 (1.6%)	
Neoadjuvant			
No	148 (74.7%)	52 (26.2%)	0.030*
Yes	50 (25.2%)	7 (11.8%)	
PNI			
No	152 (76.7%)	41 (69.4%)	0.257
Yes	46 (23.2%)	18 (30.5%)	
LVI			
No	140 (70.7%)	35 (59.3%)	0.100
Yes	58 (29.2%)	24 (40.6%)	
Grade			
Well	25 (12.6%)	13 (22.0%)	0.201
Moderate	149 (75.2%)	40 (67.7%)	
Poor	24 (12.1%)	6 (10.1%)	
Chylous Ascites			
No	196 (99.0%)	58 (98.3%)	0.667
Yes	2 (1.0%)	1 (1.6%)	
Pneumonia			
No	195 (98.5%)	59 (100%)	0.342
Yes	3 (1.5%)	0 (0.0%)	
Acute Kidney Failure			
No	196 (99.0%)	59 (100%)	0.438
Yes	2 (1.0%)	0 (0.0%)	
AMIO			
No	182 (91.9%)	57 (96.6%)	0.215
Yes	16 (8.1%)	2 (3.4%)	

Table 2. Cont.

	Conventional (n=198)	Laparoscopy (n=59)	p†
Anastomosis Leakage			
No	185 (93.4%)	57 (96.6%)	0.361
Yes	13 (6.6%)	2 (3.4%)	
Surgical Site Infection			
No	140 (70.7%)	54 (91.5%)	0.001***
Yes	58 (29.2%)	5 (8.4%)	
	Mean±SD	**p ‡**	
Age	63±12	58±13	0.648
BMI	27.49±4.31	28.71±5.36	0.080
CEA	12.73±76.94	8.18±15.62	0.420
CA19.9	36.66±269.89	11.42±13.29	0.209
CA 125	15.32±21.35	13.15±13.19	0.127
Operation Time (minutes)	213±69	250±59	0.024*

ASA: American Society of Anesthesiology, COPD: Chronic Obstructive Pulmonary Disease, PNI: Perineural Invasion, LVI: Lymphovascular Invasion,AMIO: Acute Mechanic Intestinal Obstruction, BMI: Body Mass Index; CEA Chorioambryonic Antigen; CA: Cancer Antigen IQR: Inter Quartile Range; * p<0.05, **p<0.01, ***p<0.001 †: Chi-Square, ‡: Independent T Test.

Table 3. Prognostic factors for major complication, identified by multivariate Cox regression analysis

	Univariate			Multivariate		
Prognostic factors	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Conventional Surgery	3.134	1.594-6.161	<0.001***	2.969	1.497-5.890	0.002**
Neoadjuvant Treatment	1.654	0.915-2.991	0.096	-	-	-
M1 Stage	1.181	0.471-2.958	0.723	-	-	-
Ostomy Formation	1.565	0.898-2.729	0.114	-	-	-
BMI	1.055	1.001-1.112	0.046*	1.037	0.982-1.095	0.194
Surgery Time (minutes)	1.001	0.997-1.004	0.771	-	-	-
COPD / Asthma History	2.171	1.014-4.651	0.046*	2.002	0.907-4.421	0.086

BMI: Body Mass Index; COPD: Chronic Obstructive Pulmonary Disease, OR: Odds Ratio; CI: Confidence Interval, * p<0.05, **p<0.01, ***p<0.001 †: Chi-Square, ‡: Indipendent T Test.

The physiological advantages of laparoscopic surgery may explain our observed outcomes. Minimally invasive techniques are associated with reduced surgical trauma, diminished inflammatory response, and better preservation of immune function compared to open surgery.[16] Kampman et al.[17] documented superior inflammatory profiles following laparoscopic colorectal resection, correlating with reduced complication rates. This aligns with our finding of significantly lower surgical site infection rates in the laparoscopic group (8.4% vs. 29.2%; p<0.001), suggesting modulated inflammatory responses and improved tissue healing.

Cardiopulmonary complications represent a major concern in high-risk surgical populations. Our findings support

previous research indicating reduced cardiopulmonary morbidity with laparoscopic approaches. Schiphorst et al.[18] demonstrated significantly fewer pulmonary complications and trends toward reduced cardiac events following laparoscopic colectomy. These advantages may be particularly relevant in patients with preexisting cardiopulmonary conditions, who comprised a substantial portion of our cohort. The minimized diaphragmatic manipulation and reduced postoperative pain associated with laparoscopy likely contribute to better pulmonary function and earlier mobilization. Currie et al.[19] also reported in a meta-analysis of 40 studies reporting on 11,516 randomized patients that laparoscopic surgery reduces complications of colorectal cancer surgery but not mortality. Another meta-analysis of 24 studies concluded that laparoscopic surgery is more beneficial than open surgery in elderly individuals with colorectal cancer and should be prioritized based on the availability of the necessary technical skills and facilities.[20]

Drews et al.[21] argue that the use of laparoscopic surgery for colorectal cancer in elderly patients with high comorbidities does not increase complications and can be strongly advocated. However, the use of minimally invasive surgery in very elderly patients with low-lying rectal carcinoma should be clarified by first examining their quality of life. Obara et al.[22] report that standard laparoscopic surgical procedures can be safely performed in colorectal cancer patients receiving hemodialysis due to comorbid renal failure. Hashida et al.[23] also reported the feasibility and safety of laparoscopic surgery in a study of 108 very elderly colorectal cancer patients aged 85 years and older. Devoto et al.[24] also reported the feasibility and safety of elective laparoscopic resection in patients with colorectal cancer aged 85 years and older. Khor et al.[25] demonstrated no significant difference in incisional hernia rates between patients undergoing laparoscopic and open colorectal cancer surgery. They reported that female gender, higher body mass index (BMI), and higher ASA increased the risk of developing an incisional hernia after major colorectal cancer resection. Our study population had higher comorbidities and older age, and laparoscopic surgery had lower morbidity compared to open surgery, and even conventional surgery was a poor prognostic factor for postoperative complications.

A meta-analysis of 24 studies, including 4,592 patients in the laparoscopic surgery group and 3,865 patients in the open surgery group, reported that laparoscopic surgery significantly reduced estimated blood loss, length of hospital stay, and postoperative mortality and morbidity compared with open surgery.[26] Although laparoscopic surgery in our study was found to have a longer operative time compared with open surgery (250 min vs. 213 min; p=0.024), this difference did not have a significant negative impact on clinical outcomes. Furthermore, the literature suggests that operative times shorten with increasing surgical experience.[8,9] Wound infection and the need for ostomy were found to be less common in patients undergoing laparoscopic surgery in our study. The longer operative times observed in our laparoscopic group (250±59 min vs. 213±69 min; p=0.024) are consistent with previous reports and reflect the technical demands of minimally invasive surgery. However, this did not translate to increased complications, supporting the concept that surgical duration alone may not determine outcomes when procedures are performed by experienced surgeons.[27] The learning curve phenomenon in laparoscopic colorectal surgery is well-documented, with operative times typically decreasing as surgical teams gain experience.[28]

Our multivariate analysis revealed that while high BMI and COPD/asthma history were significant in univariate analysis, they lost independent significance when surgical approach was considered. This suggests that the benefits of laparoscopy may be particularly pronounced in these high-risk subgroups. Previous studies have specifically addressed laparoscopic outcomes in obese patients and those with respiratory comorbidities,[28] generally reporting maintained advantages despite technical challenges.

The concentration of ASA IV patients in the conventional surgery group represents an important limitation and potential source of selection bias. This reflects real-world clinical practice where surgeons may opt for open approaches in the highest-risk patients. However, the persistence of the laparoscopic advantage after multivariate adjustment suggests a genuine protective effect. Recent evidence increasingly supports the feasibility of minimally invasive surgery even in high-risk populations,[29] challenging traditional selection criteria.

Several additional limitations warrant consideration. The retrospective design introduces potential for unmeasured confounding, despite our statistical adjustments. The single-center nature limits generalizability, though it ensures consistency in surgical technique and perioperative care. Surgeon preference and evolving experience over the

study period may have influenced outcomes, though all operators were beyond their learning curve. Finally, while we focused on major complications, assessment of long-term oncological outcomes and quality of life measures would provide valuable complementary information.

Our findings have important clinical implications. They suggest that laparoscopic approaches should be considered not only for standard-risk patients but also for carefully selected complex cases with significant comorbidities. Preoperative optimization remains crucial, but concerns about increased risk with minimally invasive techniques in this population may be overstated. Rather, the physiological advantages of laparoscopy may be particularly beneficial for high-risk patients.[30]

Future research directions include prospective randomized trials specifically targeting high-comorbidity populations, cost-effectiveness analyses incorporating long-term outcomes, and studies evaluating the integration of enhanced recovery protocols with minimally invasive approaches in complex patients. Additionally, research on patient-reported outcomes and quality of life measures would complement the complication-focused outcomes presented here.

Conclusion

In conclusion, our study demonstrates that laparoscopic colorectal surgery is associated with significantly reduced major complications compared to open surgery, even in a patient population with high comorbidity burden treated at a tertiary cardiac center. The laparoscopic approach emerged as an independent protective factor, suggesting its potential as the preferred option for appropriately selected patients regardless of comorbidity status. These findings support the continued expansion of minimally invasive techniques in complex surgical populations, while highlighting the need for careful patient selection and surgical expertise. Prospective studies are warranted to validate these results and further refine patient selection criteria.

Disclosures

Ethics Committee Approval: The study protocol received approval from the Institutional Research and Ethics Committee of the Health Sciences University Koşuyolu High Specialization Hospital (Date: 03/09/2024, No: 2024/15/902).

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Management and outcomes of patients who developed tracheoesophageal fistula in the cardiovascular surgery intensive care unit

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ABSTRACT

Introduction: Tracheoesophageal fistula (TEF) is a rare but serious complication, particularly in critically ill patients undergoing prolonged mechanical ventilation or tracheostomy. Management of non-malignant TEFs in intensive care settings is particularly challenging. This retrospective descriptive case series was designed to evaluate the characteristics, management strategies, treatment methods and clinical outcomes of patients with acquired TEF in a cardiovascular surgery intensive care unit, with Ethics Committee approval.

Materials and Methods: All patients who were followed for more than 24 hours in the cardiovascular surgery intensive care unit during a 6.5-year period were evaluated. Adult patients who underwent endoscopy due to suspected TEF and were confirmed to have TEF were included in the study. The following parameters were examined: patient age, sex, type of surgery performed, use of mechanical ventilation, presence of tracheostomy and tracheostomy-related complications, length of ICU stay, use of inotropic support, presence of infections, timing of TEF development, TEF treatment methods, mortality, and outcomes.

Results: Total of 23 patients underwent endoscopic evaluation due to suspected TEF. Among these, TEF was confirmed in 10 patients. Four of these patients underwent endoscopic and surgical treatment for TEF. These methods included endoscopic clipping alone (n=1), surgical repair alone (n=2), or a combination of endoscopic clipping and surgical repair (n=1). Two of these four patients died during hospitalization. One patient was discharged with complete recovery, while the other was discharged with a tracheostomy.

Conclusion: Given the complexity of TEF management, both surgical and endoscopic treatment approaches should be undertaken in specialized centers with a multidisciplinary team.

Keywords: Cardiac surgery, endoscopic methods, tracheoesophageal fistula

Introduction

Tracheoesophageal fistula (TEF) is an abnormal communication between the trachea and the esophagus. It can be either congenital or acquired. Although rare, it represents a serious, difficult-to-treat complication, particularly in patients undergoing prolonged mechanical ventilation, and is associated with increased morbidity and mortality.

Acquired TEFs most commonly occur due to erosion of the tracheal and esophageal walls caused by endotracheal or tracheostomy tube cuffs. The incidence has declined with

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the use of low-pressure cuffs. Other causes of acquired TEF include trauma, malignancy, tracheostomy, infections, and certain surgical procedures such as aortic surgery.

Management of non-malignant TEFs in intensive care settings is particularly challenging. Recurrence is common. In appropriate candidates, either surgical repair or endoscopic approaches—such as clipping or stenting—may be employed. In a limited number of recent studies in the literature, perioperative mortality in patients undergoing surgical intervention has been reported to be approximately 5%.[1] Endoscopic approaches are also recommended in selected patients.The non-surgical management of these patients is also complex and requires multidisciplinary care.

This study was designed to evaluate the characteristics of patients who developed acquired TEF in a cardiovascular surgery intensive care unit, the management strategies, the treatment methods and the clinical outcomes.

Materials and Methods

This study was designed as a retrospective descriptive case series (without comparative statistics) with the approval of the Koşuyolu High Specialization Training and Research Hospital Ethics Committee (Date: 05/08/2025, No: 2025/13/1200) and it's conducted according to Helsinki Declaration.

All patients followed in the cardiovascular surgery intensive care unit (ICU) for more than 24 hours between January 1, 2019, and June 30, 2025, were evaluated. This included patients who underwent cardiovascular and thoracic surgery, those awaiting or having undergone heart or lung transplantation, patients on venoarterial (VA) or venovenous (VV) extracorporeal membrane oxygenation (ECMO), and those who underwent peripheral arterial surgery. The total number of patients followed and treated in the intensive care unit during this period was recorded.

In the intensive care unit, tracheostomy cuff pressures in all patients are monitored primarily by palpation (they should be about the size of an earlobe), monitoring inspiratory and expiratory tidal volumes on the ventilator, and assessing for air leaks in the neck. These checks are performed several times a day and only when necessary. While cuff pressure monitoring is not routinely used, intermittent cuff pressure measurements are also made.

Adult patients who underwent endoscopy with suspicion of TEF in the intensive care unit and whose diagnosis of TEF was confirmed were included in the study. Patients who underwent endoscopy for other reasons were excluded. The following parameters were examined: Patient age, sex, type of surgery performed, use of mechanical ventilation, presence of tracheostomy, tracheostomy technique, presence of tracheostomy-related complications, length of ICU stay, use of inotropic support, presence of infections, timing of TEF development, nutritional and medical management due to TEF, TEF treatment methods, mortality, and outcomes.

Statistical Analysis

Due to the limited number of patients diagnosed with TEF (n=10), statistical evaluation was performed using descriptive statistics. The total number of patients admitted to the intensive care unit during the study period was recorded. Data were presented as the number of patients who developed TEF. Patients who underwent endoscopy due to suspected TEF were reported as both number and percentage. The presence of cerebrovascular events, use of inotropic support, presence of sepsis, length of ICU stay, and time to TEF development were calculated as median values with minimum and maximum ranges. Mortality among patients who developed TEF was expressed as a number and percentage relative to the total number of TEF cases. The treatment method applied for TEF was described on a per-patient basis.

Results

Between January 2019 and June 2025, a total of 22,273 patients were admitted to the cardiovascular surgery intensive care unit for more than 24 hours. During this period, a total of 23 patients underwent endoscopic evaluation due to suspected TEF. Among these, TEF was confirmed in 10 patients. The median age of patients with confirmed TEF was 56 years (range: 27–76), and 6 of them were female. The demographic characteristics of the patients included in the study are presented in Table 1. In the remaining 13 patients who underwent endoscopy for suspected TEF, no fistula was identified. However, esophageal mucosal thinning was observed in 2 of these patients.

All patients had undergone percutaneous tracheostomy using the single dilatation technique (Blue Rhino method). None of the patients received surgical tracheostomy.

The clinical signs that led to suspicion of TEF were as follows: Appearance of enteral feeding through the tracheostomy cannula (n=6), presence of air through the na-

Table 1. Demographic characteristics (n=10)

Age (years)	56.2 (27-76)	
Gender (F/M)	6 / 4	
Diagnosis/Surgery performed (n)	ARDS + VV ECMO	2
	CABG + MEDIASTINITIS	1
	CABG	1
	AASGI	1
	AASGI +CABG	1
	AVR +MVR +TRICUSPIT RING	1
	MVR + TRICUSPIT RING+ PFO AND ASD CLOSURE	1
	BULLOUS LUNG +VV ECMO	1
	REDO MVR + INFECTIVE ENDOCARDITIS	

ARDS: Acute Respiratory Distress Syndrome; VV-ECMO: Veno-Venous Extracorporeal Membrane Oxygenation; CABG: Coronary Artery Bypass Grafting; AASGI: Ascending Aorta Separate Graft Interposition; AVR: Aortic Valve Replacement; MVR: Mitral Valve Replacement; PFO: Patent Foramen Ovale; ASD: Atrial Septal Defect.

sogastric tube (n=1), abdominal distension (n=2), and incidental detection during rigid bronchoscopy performed for tracheal stenosis (n=1). The location of the TEF identified via endoscopy was between 17–20 cm from the incisors in 8 patients and starting at 14 cm in 2 patients. The fistula lengths ranged from 1 to 4 cm.

The median time between endotracheal intubation and the development of TEF was 38 days (range: 18–67). The median duration of intubation before tracheostomy was 17.5 days (range: 8–34), while the median time between tracheostomy and TEF development was 18 days (range: 0–60).

Prior to or at the time of TEF diagnosis, 9 patients were receiving inotropic and/or vasopressor support. Additionally, 9 patients were either being treated for sepsis or were septic at the time TEF was diagnosed. Mediastinitis was present in 2 patients. Only 2 patients were discharged from the hospital (Table 2).

Among the patients who developed TEF, 8 had undergone tracheostomy due to prolonged mechanical ventilation, while in 2 patients, TEF developed iatrogenically during tracheostomy procedures. In one patient, the TEF occurred during percutaneous tracheostomy and in the other, it developed during rigid bronchoscopy performed for tracheal stenosis.

One patient with iatrogenic TEF had been on VV-ECMO support due to ARDS secondary to COVID-19 pneumonia. On the 8th day of ECMO support, the patient underwent cesarean section and delivered a live infant. On the 27th day of post-cesarean intubation, a percutaneous tracheostomy was performed under bronchoscopic guidance while ECMO support was ongoing. The patient was

Table 2. Clinical characteristics of patients who developed TEF

Duration of entubation before tracheostomy (days) median (min–max)	17.5 (8-34)
Duration from tracheostomy to TEF diagnosis (days) median (min–max)	18 (0-60)
Duration from Intubation to TEF diagnosis (days) median (min–max)	38 (18-67)
Inotropic and/or vasopressor support prior to or during TEF (n)	6
Previous or ongoing sepsis (n)	9
Mediastinitis (n)	2
Discharge from hospital (n)	3
Exitus (n)	7

TEF; Tracheoesophageal fistula.

weaned from ECMO on day 40 and subsequently transferred to the ward. A follow-up bronchoscopy performed in the ward revealed significant tracheal stenosis just below the vocal cords. However, during the rigid bronchoscopy procedure, an iatrogenic tracheoesophageal fistula developed. The patient underwent two surgical interventions and was eventually discharged with a tracheostomy and percutaneous endoscopic jejunostomy (PEJ) due to recurrent laryngeal nerve paralysis. In the 8th month following discharge, the patient experienced massive bleeding from the tracheostomy site. Despite emergency surgery, further repair was not possible, and the patient died due to hemorrhagic complications.

The other patient who developed iatrogenic TEF underwent ascending aortic graft interposition surgery due to ascending aortic dissection and had a prolonged mechanical ventilation duration. This patient experienced postoperative cerebrovascular events (CVE). Neither surgical repair nor endoscopic treatment was considered. Enteral feeding was discontinued, and TPN was initiated. The tracheostomy cannula balloon was adjusted to remain below the fistula site. The patient was transferred to another suitable center for continuation of treatment under these conditions.

Among the patients, 6 developed CVE, had low Glasgow Coma Scale (GCS) scores, infections, poor general condition, and required high-dose inotropic support. Due to these factors, neither intervention nor surgery for TEF was deemed appropriate. These 6 patients died due to causes other than TEF, such as sepsis.

Among the patients, four received treatment for TEF as follows:

Endoscopic clipping alone (n=1)

Surgical repair alone (n=2),

Combined endoscopic clipping and surgical repair (n=1).

The endoscopic and/or surgical interventions performed for TEF and their outcomes are summarized in Table 2 and 3. Two of these four patients died during hospitalization. One patient was discharged with complete recovery, while the other was discharged with a tracheostomy due to bilateral vocal cord paralysis. One of the patients who died was a 68-year-old who had undergone mitral valve replacement (MVR) and tricuspid ring annuloplasty. The patient required prolonged mechanical ventilation due to pneumonia and the need for inotropic and vasopressor support. TEF was diagnosed during endoscopy performed for abdominal distension. The patient was taken to surgery for TEF repair after pneumonia improved and inotropic support was discontinued. Primary repair and jejunostomy were performed, and the patient was extubated postoperatively. However, reoperation was required days later due to air leakage from the tracheostomy site. Despite this, the patient died due to sepsis and renal failure during the postoperative period. The second patient who died was on VV-ECMO support due to bullous lung disease and could not be weaned off. This patient underwent two endoscopic clipping procedures but ultimately died from multidrug-resistant Klebsiella sepsis.

Table 3. Interventions, surgeries, and outcomes for TEF

Interventions and surgical procedures	Reoperation	Result	n
Endoscopic clip placement and percutaneous endoscopic jejunostomy	Additional clip placement	Exitus	1
Primary repair and jejunostomy	-	Recovery	1
		Exitus	1
Endoscopic clip placement	Tracheal ring resection and end-to-end anastomosis + fistula tract repair (with muscle flap) + percutaneous jejunostomy (1. reoperation) Placement of a silicone cylindrical stent + tracheostomy cannula on the stent (2. reoperation)	Discharge with tracheostomy (Exitus with bleeding after 8 months)	1

TEF: Tracheoesophageal fistula.

Discussion and Conclusion

In this study, a total of 22,273 patients admitted to the cardiovascular surgery intensive care unit for more than 24 hours over a 6.5-year period were reviewed. Endoscopy was performed in 23 patients with suspected TEF. It was confirmed in 10 patients, while 11 patients showed no evidence of TEF, and esophageal thinning was observed in 2 patients. Among the patients with TEF, four received treatment: Endoscopic intervention alone (n=1), surgical repair alone (n=2), or a combination of endoscopic and surgical interventions (n=1). Surgical or endoscopic treatment was not planned for six patients due to sepsis or CVE. In these patients, the tracheostomy cannula balloon was advanced to remain below the fistula, and TPN was initiated for feeding. The overall mortality rate among the 10 patients diagnosed with TEF was 70%. These deaths were primarily attributed to sepsis, CVE, and/or cardiac failure. The mortality rate among the four patients who underwent endoscopic and/or surgical treatment was 50%. One patient, who was discharged with a tracheostomy cannula, died six months later due to massive bleeding at the TEF site. In this study, 60% of the patients were receiving inotropic support at the time of TEF diagnosis, and 90% were on antibiotic therapy due to pneumonia or sepsis.

Non-malignant TEFs remain a rare but significant complication in intensive care units despite advances in diagnosis, treatment, and increased awareness. Surgical repair of TEFs has been reported to result in excellent or good long-term anatomical and functional outcomes in 93–93% of cases.[2] Preparation for surgical correction is crucial and may take several months. Key factors for successful repair include weaning the patient off mechanical ventilation, adequate treatment of infections, respiratory physiotherapy, and full nutritional optimization.[3]

In this study, among the four patients in whom TEF closure was achieved via endoscopic or surgical methods, two underwent surgery after being transferred from the intensive care unit (ICU) to the general ward. Both of these patients were successfully discharged. In the remaining two patients, TEF closure was performed via endoscopic or surgical intervention during their ICU stay when their condition was deemed suitable. However, both patients died in the ICU due to sepsis.

It was considered that the success of TEF treatment in these patients was strongly influenced by the patient's overall clinical condition, the presence of underlying comorbidities, and a history of sepsis. According to the literature, the number of patients reported in studies addressing TEF treatment modalities and the timing of interventions remains limited. Each case must be evaluated individually to determine the optimal timing and type of surgical or endoscopic intervention.

The most common cause of TEF is prolonged mechanical ventilation. Tracheal ischemia caused by endotracheal tube or tracheostomy cuff pressure is a significant factor in the development of TEF. Ischemia and infections resulting from sustained local pressure contribute to the pathogenesis of TEF. Cuff pressure-related TEFs typically present with symptoms within 21–30 days.[4] Tracheoesophageal fistulas have been reported in patients who were endotracheally intubated or tracheostomized, with a median mechanical ventilation duration of approximately 30 days. In our study, the median time between endotracheal intubation and the diagnosis of TEF was 38 days (range: 18–67). Eight of the patients had a prolonged duration of mechanical ventilation prior to the development of TEF and were receiving antibiotic therapy due to concurrent infections. All patients were fed enterally via a nasogastric tube prior to the diagnosis of TEF, provided they had adequate enteral tolerance. Other reported causes of TEF include complications related to tracheal or esophageal surgery, aortic surgery, iatrogenic injuries, and trauma.[2] In our study, iatrogenic TEF occurred in 2 out of 10 patients, during percutaneous tracheostomy in one case and during rigid bronchoscopy in another.

In TEFs caused by endotracheal tube or tracheostomy cuff pressure, the defect is typically located in the mid or distal trachea.[5] In this study, TEFs were most commonly observed between 17 and 20 cm from the incisors, corresponding to the position of the endotracheal or tracheostomy tube cuff. The fistulas were primarily located in the mid to distal trachea. In two patients, the TEF was identified at approximately 14 cm from the incisors. One of these patients was on VV-ECMO support with vasopressor infusion due to ARDS. The other had undergone AVR + MVR + tricuspid ring annuloplasty and was hemodynamically unstable, requiring inotropic support.

During the COVID-19 pandemic, an increase in the incidence of TEF was observed, rising from 0.5% to 1.5%.[6] Following the pandemic, 23% of patients referred to thoracic surgery centers with tracheolaryngeal complications were reported to have developed TEF.[7] During this period, the management of TEFs related to prolonged mechanical

ventilation was particularly challenging. Among patients undergoing endoscopic or surgical treatment, mortality rates as high as 43% were reported, largely due to infectious complications.[6]

In this study, two postpartum patients who developed ARDS due to COVID-19 were managed with VV-ECMO support. Both patients underwent tracheostomy during ECMO. In the first patient, tracheal stenosis was detected following 40 days of prolonged mechanical ventilation and VV-ECMO support. During rigid bronchoscopy performed for tracheal stenosis, an iatrogenic TEF occurred. The patient required multiple endoscopic and surgical interventions. She was eventually discharged with a tracheostomy due to bilateral vocal cord paralysis. While awaiting recovery of vocal cord function, the patient developed severe bleeding from the fistula site. Surgical repair was not feasible during the emergent procedure, and the patient died due to hemorrhagic complications. The second patient also underwent percutaneous tracheostomy during VV-ECMO support. A TEF was diagnosed 16 days after the tracheostomy. Surgical primary repair of the trachea and esophagus was performed 35 days after ECMO decannulation. This patient recovered fully and was discharged without a tracheostomy and with no long-term sequelae.

The management of patients with tracheoesophageal fistula involves several critical supportive measures. Restriction of oral intake, frequent oral suctioning, and head-of-bed elevation to ≥45° are essential components. In patients under mechanical ventilation, the endotracheal tube cuff should be positioned distal to the fistula. If a tracheostomy is in place, a long, adjustable tracheostomy tube should be used to ensure the cuff lies below the fistula site. H_2-receptor antagonists or proton pump inhibitors are recommended for gastric acid suppression. Nasogastric and orogastric tubes should be removed, and when feasible, a jejunostomy feeding tube may be considered for enteral nutrition.[5] In this study, it was determined that these methods were followed in all patients.

Symptoms such as coughing during oral intake, aspiration, fever, pneumonia, or air leakage via a nasogastric tube—particularly in mechanically ventilated patients—should raise suspicion for TEF.[8] The most commonly reported symptoms of TEF include respiratory distress, dysphagia, and recurrent pulmonary infections.[5] Patients may present with feeding difficulties, including choking during meals, and recurrent aspiration pneumonias, which can be life-threatening. Even in the absence of overt aspiration pneumonia, patients presenting with severe septic states may have an underlying TEF that should not be overlooked.[9] In our study, the most common clinical sign suggesting TEF was the presence of enteral feeding material leaking through the tracheostomy cannula (n=6). Additional findings included air leakage from the nasogastric tube (n=1) and abdominal distension (n=2). However, especially in patients undergoing prolonged mechanical ventilation, clinicians should maintain a high index of suspicion for TEF and conduct a thorough and vigilant assessment.

Interventional or Surgical Treatments in Patients with TEF;

Endoscopic Approaches

In the treatment of benign TEF, after supportive care, surgical intervention or endoscopic methods such as stenting or clipping are performed at the most appropriate time. Stents are generally placed in the esophagus and less frequently in the airway. Airway stents are used when esophageal stenting fails to adequately close the fistula or cannot be placed.[10] However, stents themselves may also cause TEF. Therefore, close follow-up of patients after stent placement is crucial.[11] Endoscopic treatment methods such as clipping or metallic stenting should be considered as a therapeutic option in patients who developed TEF following COVID-19 infection.[6] In the literature, endoscopic management has been reported to achieve successful fistula closure in approximately 57% of cases, with an average of 1.7 procedures per patient. However, 43% of patients eventually required surgical repair.[12] In our study, one patient who developed ARDS and underwent veno-venous extracorporeal membrane oxygenation (VV-ECMO) received two endoscopic interventions with clip placement at the site of the TEF, resulting in successful closure. Unfortunately, the patient later died due to multidrug-resistant sepsis. In another case, following VV-ECMO decannulation for COVID-19-related ARDS, endoscopic clips placement was attempted. Due to treatment failure, elective surgical repair was performed. Shortly thereafter, dehiscence at the anastomotic site occurred, and a cylindrical stent was endoscopically placed in the trachea. The patient was eventually discharged with a tracheostomy. Despite lower success rates and the need for repeated interventions compared to surgery, endoscopic techniques are increasingly considered a valuable component in the management of TEF in selected patients.[12]

Surgical Treatment of TEF

In thoracic surgery centers, segmental tracheal resection with end-to-end anastomosis and esophageal suturing is the preferred treatment for patients who develop post-intubation TEF, particularly those with adequate nutrition and spontaneous respiration. In such cases, perioperative mortality has been reported as 3.8%.[13] It is crucial to select an individualized surgical approach to eliminate the fistula and restore normal respiration and swallowing. The use of muscle flap interposition can reduce the risk of fistula recurrence in high-risk conditions such as prior esophagectomy or cervical radiation.[14] Deciding on the appropriate surgical strategy for TEF is a complex process. Factors influencing this decision include the location, size, and morphology of the fistula, underlying comorbidities, nutritional status, and the type and number of previous reconstructive procedures.[15]

Surgical Treatment

In patients who develop TEF after intubation in a thoracic surgery center, the preferred treatment for those with spontaneous respiration and adequate nutrition is segmental tracheal resection with end-to-end anastomosis and esophageal suturing. Perioperative mortality in these patients has been reported as 3.8%.[13] It is crucial to select an individualized surgical approach to eliminate the fistula and restore normal respiration and swallowing. Muscle flap interposition reduces the risk of fistula recurrence in high-risk cases such as those with prior esophagectomy or cervical radiation.[14] Deciding on the surgical strategy and treating TEF is a complex process. Factors influencing the strategy include the location, size, and contour of the TEF, underlying disease, malnutrition, and the type and number of previous reconstructive interventions.[15]

The surgical approach most commonly involves an anterior technique with tracheal resection and end-to-end anastomosis. In cases of large-sized fistulas, atypical surgical techniques may be required. Esophageal defects or membranous tracheal wall disruptions can be repaired with primary suturing. Additionally, placement of a T-tube combined with protective tracheostomy may be utilized as part of the surgical repair strategy. To separate the esophagus from the trachea and reduce the risk of recurrence, muscle flaps harvested from pretracheal muscles or the sternocleidomastoid can be interposed between the two structures.[7] For patients requiring nutritional support, simultaneous placement of gastrostomy and jejunostomy tubes is recommended to allow both enteral feeding and gastric decompression. Surgical intervention should ideally be postponed until the patient can be weaned off mechanical ventilation. In surgical repair of TEF, reported morbidities include partial dehiscence of the tracheal anastomosis, transient recurrent laryngeal nerve palsy, temporary dysphagia, tracheal anastomotic granulation tissue formation, and surgical site infections.[13]

In our study, one patient who underwent surgical closure of TEF developed bilateral recurrent laryngeal nerve paralysis and dehiscence at the tracheal anastomosis site. In patients undergoing tracheal resection and anastomosis, routine postoperative bronchoscopic evaluations are crucial to assess the integrity of the anastomotic suture line.

Clinicians should maintain a high index of suspicion for TEF in patients undergoing prolonged mechanical ventilation, tracheostomy procedures, or during episodes of infection, particularly in those followed with a tracheostomy. To prevent TEF in intensive care units, continuous monitoring of tracheal or endotracheal tube cuff pressures, ensuring adequate nutritional support, close monitoring of at-risk patients, and proper suctioning techniques are essential.

Tracheoesophageal fistula is a rare but serious complication, particularly in critically ill patients undergoing prolonged mechanical ventilation or tracheostomy. Given the complexity of TEF management, both surgical and endoscopic treatment approaches should be undertaken in specialized centers with a multidisciplinary team. Such an approach significantly improves treatment success and patient outcomes.

Disclosures

Ethics Committee Approval: This study was with the approval of the Koşuyolu High Specialization Training and Research Hospital Ethics Committee (Date: 05/08/2025, No: 2025/13/1200).

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Relationship between bronchoscopic culture results and clinical and demographic factors

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ABSTRACT

Introduction: Asthma and Chronic Obstructive Pulmonary Disease (COPD) are prevalent chronic respiratory diseases worldwide. In both conditions, respiratory tract infections are a significant cause of morbidity and mortality. Bronchoscopic sampling is an important diagnostic method for evaluating the microbiological flora. There is limited data on whether the microbiological culture results differ in patients with asthma and COPD from patients without asthma and COPD. This study aimed to investigate potential differences in the respiratory tract microbial profiles of asthma, COPD, and non-asthma/non-COPD patients.

Materials and Methods: This study included patients aged 18 years and older who underwent bronchoscopy between 2019 and 2024. Bronchoscopic samples were collected using the bronchoalveolar lavage method, and the microbiological culture results of these samples were examined in a laboratory setting. All procedures were performed using a flexible bronchoscope under local anesthesia and sedation.

Results: A total of 526 patients were included in the study: 389 Without asthma and COPD, 35 with asthma, and 102 with COPD. The age in the COPD group was significantly higher than in the other groups (p=0.009). There was no difference between gender and procedure indications. Heart failure was more common in the asthma group, and coronary artery disease was more frequent in the COPD group. No significant difference was found between the groups in microbiological cultures (p>0.05).

Conclusion: The bronchial microbial profile in patients with asthma and COPD did not differ from those without these diseases. These findings suggest that microbial colonization is independent of the disease.

Keywords: Bronchoalveolar lavage, bronchoscopy, culture, lung diseases

Introduction

Asthma and chronic obstructive pulmonary disease (COPD) are chronic inflammatory airway diseases with high global prevalence.[1] In both diseases, structural and functional changes are observed in the airway mucosa, increasing patients' susceptibility to infections.[2]

Lower respiratory tract infections are significant causes of morbidity and mortality, leading to hospitalizations and deaths, and can result in more severe clinical presentations, especially in individuals with chronic respiratory conditions.[3] Infections that develop in these patients can alter the microbiological spectrum. Bronchoscopy is a fre-

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quently used invasive procedure for both diagnostic and therapeutic purposes, providing valuable information for microbiological diagnosis through direct sampling from the lower respiratory tract.[4] In recent years, the use of flexible bronchoscopy has become widespread.[5] Evaluating bronchoscopy culture results plays an important role in identifying the causative agent of infection and guiding intensive antibiotic treatment.

The differences in microbiological growth detected in bronchoscopic samples from asthma and COPD patients compared to individuals without asthma-COPD have not been sufficiently elucidated. This study investigated the effect of airway microbial colonization on these diseases by comparing the demographic characteristics, comorbid conditions, and bronchoscopic microbiological culture results of asthma patients, COPD patients, and non-asthma-COPD patients who underwent bronchoscopy.

Materials and Methods

This retrospective study included patients over 18 years of age who underwent bronchoscopy in a tertiary hospital's pulmonology clinic between 2019 and 2024. Patients receiving tuberculosis treatment, those with asthma-COPD overlap syndrome, and those whose cultures were not taken were excluded. The study comprised three groups: Asthma, COPD, and non-asthma/COPD bronchoscopy patients. Patients who underwent bronchoscopy and whose medical records were fully accessible were included in the study. This study was conducted in accordance with the Declaration of Helsinki and ethical committee approval was obtained from Kahramanmaraş Sütçü İmam University, on January 9, 2025 (decision number 21), and patient file records from the hospital information management system were retrospectively reviewed.

The study analyzed patients' demographic data (age and gender), smoking history, concomitant diseases (e.g., diabetes mellitus, hypertension, COPD, etc.), and microbiological culture results of samples taken during bronchoscopy. The obtained data were transferred to a digital environment in an appropriate format for statistical analysis. Information regarding prior antibiotic use was also reviewed from patients' medical records. Data on whether patients had received antibiotic therapy within the two weeks preceding bronchoscopy, as well as the antibiotic type, duration, and treatment setting (ICU vs. non-ICU), were recorded. Patients who had received antibiotics within this period were analyzed separately to assess their potential effect on microbiological culture results and subgroup comparisons were performed between antibiotic-exposed and non-exposed patients. Files containing incomplete or insufficient information were included in the study.

Bronchoscopy procedures were performed in our clinic according to standard protocols, generally using a flexible bronchoscope under local anesthesia and sedation. During bronchoscopy, bronchoalveolar lavage (BAL) was performed in the segmental or subsegmental bronchus corresponding to the radiologically most affected area. A total of 100–150 mL of sterile 0.9% saline was instilled in three to five sequential lavage fractions, each approximately 20–50 mL. The first aliquot was discarded to minimize contamination from the upper airway, and the remaining lavage samples were pooled for microbiological analysis. All procedures were performed using a flexible bronchoscope under local anesthesia with topical lidocaine and conscious sedation (midazolam). To avoid contamination, sterile saline and collection traps were used for each patient, and bronchoscope channels were disinfected and sterilized according to international guidelines between procedures. The collected BAL samples were immediately transported to the microbiology laboratory for culture and further analysis. Indications for the procedure included persistent radiological infiltration, hemoptysis, suspected endobronchial lesions, and chronic cough. Bronchoscopic samplings included bronchoalveolar lavage (BAL), endobronchial biopsy, transbronchial lung biopsy, and brush biopsies. The collected samples were sent to the laboratory for microbiological analysis, and culture results were evaluated retrospectively.

Statistics

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 27.0 (IBM Corp., Chicago, IL, USA). The normality of data distribution was evaluated through both visual methods (histograms and probability plots) and analytical tests (Kolmogorov-Smirnov test). Visual and statistical analyses indicated that the continuous variables were non-parametric distributed. Descriptive statistics were used to summarize baseline demographic and clinical characteristics. Continuous variables are presented as medians with interquartile ranges (IQRs), whereas categorical variables are expressed as frequencies and percentages. For multiple group comparisons, the Kruskal-Wallis test followed by the Dunn-Bonferroni post hoc test was applied for continuous variables, and chi-square tests were used for categorical variables. A p-value of <0.05 was considered indicative of statistical significance. Figure 1 was created using GraphPad Prism, version 10.0 (GraphPad Software, San Diego, CA, USA).

Results

A total of 526 patients were included in the study, comprising 389 patients without asthma or COPD, 35 with asthma, and 102 with COPD. The median age was significantly higher in the COPD group compared to patients without asthma or COPD (78 vs. 74 years, p=0.009). No significant difference was observed between groups in terms of gender distribution (p=0.198). The primary indications for the procedure did not differ significantly among the groups (p=0.332). The most common indications across all groups were pneumonia, aspiration pneumonia, and atelectasis. Regarding comorbidities, significant differences were found in the prevalence of heart failure, coronary artery disease, and dementia. Heart failure was significantly more prevalent in the asthma group compared to patients without asthma or COPD (p <0.001). Coronary artery disease was more frequent in the COPD group than in the asthma group (p=0.031). There were no significant differences between groups in terms of intubation rates (p=0.846) or treatment units (outpatient clinic, inpatient ward, intensive care) (p=0.352) (Table 1).

Table 1. Demographic and clinical characteristics of the patients

Variable	Patients with no asthma and COPD (N=389)	Patients with asthma (N=35)	Patients with COPD (N=102)	p
Age, (years), median (IQR)	74.0 (26.0)	77 (26.0)	78.0 (15.0)	0.009*
Gender, (F), n (%)	111 (28.5)	15 (42.9)	29 (28.4)	0.198
Indication for the procedure, n (%)				
Atelectasis	55 (14.1)	4 (11.4)	15 (14.7)	0.332
Mass	27 (6.9)	5 (14.3)	12 (11.8)	
Aspiration pneumonia	113 (29.1)	4 (11.4)	19 (18.6)	
Tuberculosis	26 (6.7)	2 (5.7)	8 (7.8)	
Secretion	40 (10.3)	7 (20.0)	13 (12.8)	
Pneumonia	111 (28.5)	10 (28.6)	33 (32.4)	
Diagnostic	2 (0.5)	0 (0.0)	0 (0.0)	
Cough	2 (0.5)	0 (0.0)	0 (0.0)	
Foreign material	2 (0.5)	0 (0.0)	0 (0.0)	
Hemoptysis	11 (2.8)	3 (8.6)	2 (2.0)	
Comorbidity, n (%)				
Hypertension	181 (46.5)	18 (51.4)	61 (59.8)	0.056
Chronic kidney disease	42 (10.8)	5 (14.3)	9 (8.8)	0.652
Cerebrovascular Disease	136 (35.0)	9 (25.7)	24 (23.5)	0.060
Heart Failure	47 (12.1)	12 (34.3)	26 (25.5)	<0.001Ψ
Coronary Artery Disease	80 (20.6)	4 (11.4)	31 (30.4)	0.031¥
Dementia	105 (27.0)	12 (34.3)	14 (13.7)	0.009¥
Diabetes Mellitus	95 (24.4)	12 (34.3)	19 (18.6)	0.142
Intubated, n (%)	73 (18.8)	6 (17.1)	17 (16.7)	0.846
Unit, n (%)				
Outpatient clinic	47 (12.1)	5 (14.3)	17 (16.7)	0.352
Inpatient ward	50 (12.9)	7 (20.0)	9 (8.8)	
Intensive care	292 (75.1)	23 (65.7)	76 (74.5)	

(*) p<0.05 for patients with no asthma and COPD vs patients with COPD; (Ψ) p<0.05 for patients with no asthma and COPD vs patients with asthma; (¥) p<0.05 for patients with asthma vs patients with COPD; Abbreviations: COPD, Chronic Obstructive Pulmonary Disease.

The overall distribution of microbial growth types including gram-negative bacteria, gram-positive bacteria, and yeast did not significantly differ between groups, whether analyzed as continuous variables or categorical outcomes. For gram-negative bacteria, no significant difference was found in median counts across the groups (p=0.994), and categorical distribution (none, mono, multiple) also showed no significant difference (p=0.181). Similarly, gram-positive bacterial growth did not significantly vary between groups in terms of either median values (p=0.769) or categorical distribution (p=0.817). Yeast or yeast fungi were infrequently detected across all groups, and their distribution was not significantly different (p=0.552 for medians, p=0.598 for categorical levels) (Table 2). Figure 1 illustrates the percentage distribution of microbial growth patterns by group, indicating broadly similar proportions of none, mono, and multi-organism growth across the patient categories.

The comparison of microbial isolates across treatment units revealed that patients in the intensive care unit (ICU) had significantly higher rates of both gram-negative and gram-positive bacterial growth compared to those in outpatient clinics and inpatient wards (p<0.001 for both). While the median values for yeast or yeast fungi remained zero across all units, gram-negative bacteria were less frequently observed in ICU patients, both in mono- and multi-organism growth categories. Similarly, ICU patients showed a lower prevalence of gram-positive bacteria (Table 3).

With regard to smoking history, there were no statistically significant differences in microbial distribution among non-smokers, current smokers, and former smokers (p>0.05 across all microorganism types) (Table 4).

The analysis according to intubation status revealed a significant difference in microbial profiles. Intubated patients had a lower median count of gram-negative bacteria but a significantly higher presence of gram-positive bacteria (p=0.007 and p=0.004, respectively) (Table 5).

Figure 2 highlights a higher concentration of pathogens particularly among ICU patients and intubated individuals, with variations observed across smoking categories and diagnostic groups.

Table 2. Comparison of the number of microorganisms according to the diagnosis

Variable	Patients with no asthma and COPD (N=389)	Patients with asthma (N=35)	Patients with COPD (N=102)	p
Gram-negative bacteria, median (IQR)	1 (0)	1 (1)	1 (0)	0.994
Gram-positive bacteria, median (IQR)	0 (1)	0 (1)	0 (1)	0.769
Yeast or yeast fungi, median (IQR)	0 (0)	0 (0)	0 (0)	0.552
Gram-negative bacteria, n (%)				
None	278 (71.5)	23 (65.7)	77 (75.5)	0.181
Mono	105 (27.0)	9 (25.7)	25 (24.5)	
Multiple	6 (1.5)	2 (5.7)	0 (0.0)	
Gram-positive bacteria,n (%)				
None	96 (24.7)	7 (20.0)	20 (19.6)	0.817
Mono	233 (59.9)	22 (62.9)	67 (65.7)	
Multiple	60 (15.4)	6 (17.1)	15 (14.7)	
Yeast or yeast fungi, n (%)				
None	357 (91.8)	33 (94.2)	95 (93.1)	
Mono	31 (8.0)	1 (2.9)	6 (5.9)	
Multiple	1 (0.3)	1 (2.9)	1 (1.0)	

COPD: Chronic Obstructive Pulmonary Disease; IQR: Interquartile Range.

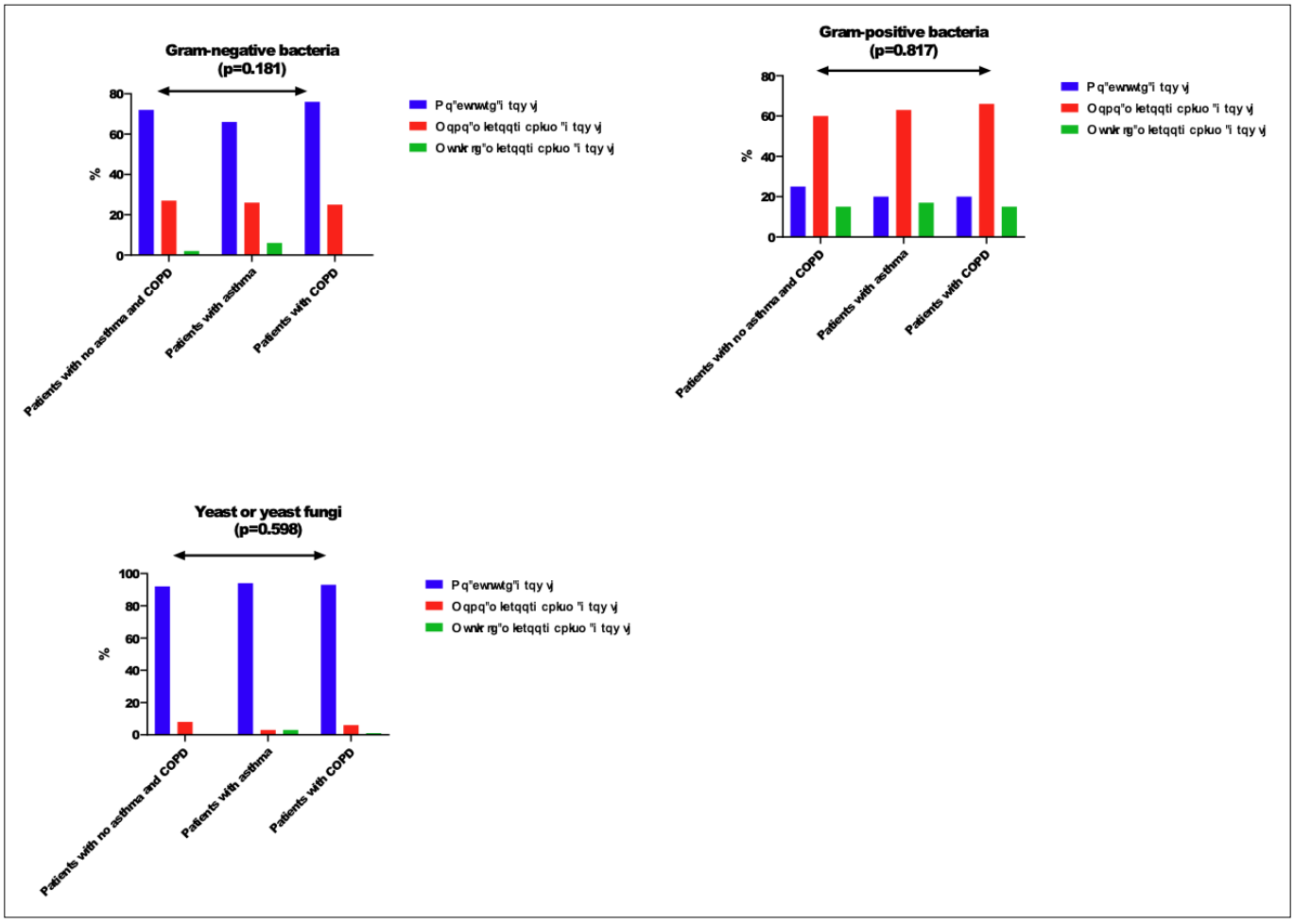

Figure 1. Percentage distribution of microbial growth counts across patient groups.
COPD: Chronic Obstructive Pulmonary Disease.

Discussion

In our study, we compared microbiological growth patterns and clinical variables in patients with asthma, COPD, and those with neither condition among 526 patients who underwent bronchoscopy. Our findings revealed that the respiratory microbiota is shaped more by clinical status (intubation, ICU admission) and care setting rather than by diagnostic groups.

Asthma typically begins in childhood.[6] The aging population increases the risk of chronic obstructive pulmonary disease.[7] Our findings showed that the mean age of patients in the COPD group was statistically higher, supporting the notion that COPD is a disease that increases with age. No significant differences were found between the groups regarding gender distribution and indications for bronchoscopy. This suggests that the microbiological findings observed in our study were not affected by gender-related biases. One of the most significant risk factors for COPD is smoking.[8] In our study, smoking was also significantly higher in COPD patients.

The relationship between asthma and cardiovascular diseases has not been fully elucidated. A study by Nasreen et al. found a higher risk of hypertension in asthmatic patients compared to a control group. Similarly, according to a study by Cristiansen et al., the risk of hypertension increases with asthma severity.[9,10] When comorbidities were evaluated, it was found that the prevalence of heart failure was more common in the asthma group, while coronary artery disease was more frequent in the COPD group. This aligns with the literature indicating that asthma and COPD are associated with systemic inflammation, not just limited to the respiratory system, and can increase the risk of cardiovascular disease. Research has shown that asthma is a risk factor for dementia. In our study, it was found to be significantly higher in the asthma group.[11] The significant difference in dementia prevalence is noteworthy, particularly regarding advanced age and the presence of systemic diseases.

Table 3. Comparison of the number of microorganisms according to the treatment unit of the patients

Variable	Outpatient clinic	Inpatient ward	Intensive care	p
Gram-negative bacteria, median (IQR)	1 (1)	1 (1)	1 (0)	<0.001*Ψ
Gram-positive bacteria, median (IQR)	0 (1)	0 (1)	0 (0)	<0.001*
Yeast or yeast fungi, median (IQR)	0 (0)	0 (0)	0 (0)	0.324
Gram-negative bacteria, n (%)				
None	28	25	69	<0.001
Mono	31	37	256	
Multiple	9	4	67	
Gram-positive bacteria,n (%)				
None	36	44	289	<0.001
Mono	31	22	86	
Multiple	1	0	7	
Yeast or yeast fungi, n (%)				
None	64	58	364	0.222
Mono	3	8	7	
Multiple	1	0	1	

COPD: Chronic Obstructive Pulmonary Disease; IQR: Interquartile Range; (*) p<0.05 for outpatient clinic vs intensive care; (Ψ) p<0.05 for inpatient ward vs intensive care

Table 4. Comparison of the number of microorganisms according to the smoking

Variable	Non smokers (N=492)	Current smokers (N=26)	Former smokers (N=8)	p
Gram-negative bacteria, median (IQR)	1 (0)	1 (1)	1 (1)	0.255
Gram-positive bacteria, median (IQR)	0 (1)	0 (1)	0 (0)	0.485
Yeast or yeast fungi, median (IQR)	0 (0)	0 (0)	0 (0)	0.270
Gram-negative bacteria, n (%)				
None	111	9	2	0.610
Mono	304	15	5	
Multiple	77	2	1	
Gram-positive bacteria, n (%)				
None	355	17	7	0.693
Mono	129	9	1	
Multiple	8	0	0	
Yeast or yeast fungi, n (%)				
None	455	24	7	0.052
Mono	36	1	1	
Multiple	1	1	0	

A study found that in individuals with COPD, the composition of the microbiome changed with different exacerbation subtypes during a one-year follow-up period, encompassing both stable and exacerbation phases, and certain patterns were repeated.[12] In our study, however, microbiological analyses revealed no significant difference between groups regarding the presence of gram-negative and gram-positive bacteria or yeast species. The presence of single or multiple microorganisms also showed a similar distribution. This result suggests that a diagnosis of

Table 5. Comparison of the number of microorganisms according to the intubation

Variable	Non-intubated (N=425)	Intubated (N=96)	p
Gram-negative bacteria, median (IQR)	1 (1)	0 (1)	0.007
Gram-positive bacteria, median (IQR)	0 (1)	1 (0)	0.004
Yeast or yeast fungi, median (IQR)	0 (0)	0 (0)	0.866
Gram-negative bacteria, n (%)			
None	108	11	0.012
Mono	255	67	
Multiple	62	18	
Gram-positive bacteria,n (%)			
None	296	81	0.014
Mono	122	14	
Multiple	7	1	
Yeast or yeast fungi, n (%)			
None	392	89	0.797
Mono	31	7	
Multiple	2	0	

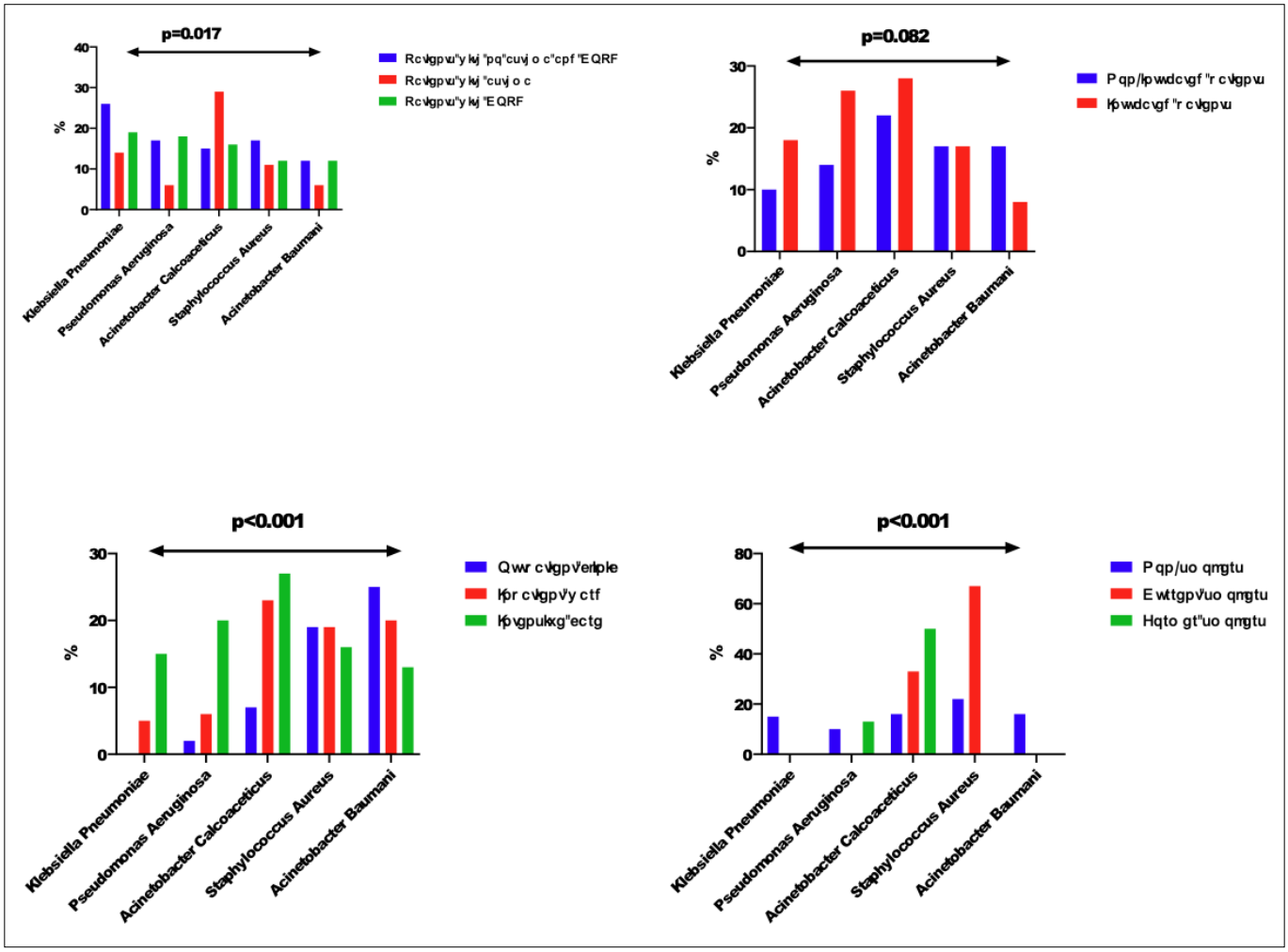

Figure 2. Comparison of the percentage of five most frequently isolated bacterial pathogens among patients according to diagnosis, intubation status, treatment unit, and smoking history.

asthma or COPD does not significantly affect the respiratory tract microbial colonization pattern. While previous studies have presented varying views on the effects of microbial colonization on disease progression in chronic airway diseases, our findings indicate heterogeneity in this area and no significant group differences in terms of microbial diversity.[13] This situation suggests that disease-related structural changes alone are insufficient to explain microbial diversity. It also suggests that microbial load does not change according to diagnosis (presence of asthma or COPD), but is likely influenced by other factors (e.g., ICU stay, intubation, antibiotic use, etc.).

Studies have reported that gram-negative bacteria are dominant in intensive care units, but gram-positive bacteria are also isolated in significant proportions.[14] The significantly higher growth of both gram-negative and gram-positive bacteria in patients hospitalized in the intensive care unit highlights the risk of hospital-acquired infections and the impact of invasive procedures (e.g., mechanical ventilation). Fungal growth was rarely found in ICU patients; this could be related to antifungal prophylaxis, short length of stay, or frequency of sampling.

Despite a low number of gram-negative bacteria in intubated patients, gram-positive bacterial growth is significantly higher. The literature also reports that gram-positive cocci are more frequently isolated in ventilator-associated infections.[15] This indicates that gram-positive pathogens (e.g., MRSA) gain importance in ventilator-associated pneumonias developing after intubation. Intubated patients are usually treated with early broad-spectrum antibiotics. These antibiotics can target gram-negatives and rapidly alter the flora.[16] Consequently, while the gram-negative load decreases, resistant gram-positive bacteria may become dominant. This finding suggests that factors such as whether the patient is in the ICU and whether they are intubated should be considered in empirical antibiotic selection. As this was a retrospective study, information on prior antibiotic exposure was obtained from existing hospital records. Although detailed data on the type, duration, and dose of antibiotics were not consistently available, the presence or absence of antibiotic therapy before bronchoscopy was documented and considered in the analysis. Prior antibiotic treatment particularly in ICU and intubated patients may have contributed to lower culture positivity rates due to partial suppression of bacterial growth. Therefore, antibiotic exposure should be recognized as an important confounding factor when interpreting microbiological growth patterns in retrospective analyses such as this one. Several studies have reported that prior antibiotic exposure can significantly alter the respiratory microbiota by suppressing susceptible bacterial populations and promoting the overgrowth of resistant organisms.[17] In ICU patients, this effect may be even more pronounced due to prolonged hospitalization, mechanical ventilation, and repeated antibiotic courses. Consequently, antibiotic therapy prior to bronchoscopy may reduce bacterial growth in culture, mask potential pathogens, or shift microbial predominance toward multidrug-resistant strains. This should be taken into account when interpreting the microbiological distribution, particularly among critically ill and intubated patients.

Smoking directly affects a person's microbiota, but this varies from person to person.[18] No significant relationship was found between smoking history and microbiological distribution. This finding suggests that smoking increases the risk of infection through indirect effects, such as impairing lung defense mechanisms, rather than directly affecting microbial growth patterns.

It demonstrates that microbiological patterns differ significantly according to the clinical characteristics of patients.[19] Entubation and intensive care unit admission show a strong association, especially with hospital-acquired and multidrug-resistant pathogens.[20] Studies have found a relationship between the intensity of antibiotic use in COPD patients and the growth of gram-negative pathogens such as Pseudomonas aeruginosa, Klebsiella pneumoniae, and Acinetobacter baumannii.[21] In our study, gram-negative bacillus colonization was found to be more prominent in COPD patients due to chronic inflammation and frequent antibiotic use.

A significant contribution of this study is that it shows that intervention and environmental factors, such as intubation and intensive care, have stronger effects on microbial distribution than diagnosis-based differentiation.

The limitations of our study include its retrospective nature and the lack of data regarding previous antibiotic use. Furthermore, the absence of detailed microbiota analyses using molecular methods in addition to microbial culture results limited a more in-depth evaluation of microbial composition. Future studies are recommended to comprehensively examine bronchial microbiota in different patient groups and correlate it with clinical outcomes.

Conclusion

In conclusion, the study reveals that microbial growths are associated more with the treatment unit and intubation status than with diagnostic groups. These data emphasize the importance of considering the patient's clinical status, hospitalization location, and history of invasive procedures in empirical antibiotic selection. Additionally, the clinical significance of microorganisms detected in respiratory tract samples should be carefully evaluated.

Disclosures

Ethics Committee Approval: This study was conducted in accordance with the Declaration of Helsinki, and ethical approval was obtained from the Ethics Committee of Kahramanmaraş Sütçü İmam University Faculty of Medicine (No: 21, Date: 09/01/2025).

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Data Availability Statement: The data that support the findings of this study are available from the Department of Pulmonology, Faculty of Medicine, Kahramanmaraş Sütçü İmam University. However, restrictions apply to the availability of these data, which were used under license for the current study and are not publicly available. Data may be obtained from the authors upon reasonable request and with permission from the relevant institutional administration.

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Original Article

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Advancing gastric cancer surgery: Oncological outcomes and novel approaches in laparoscopic D2 gastrectomy

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ABSTRACT

Introduction: Laparoscopic gastrectomy with D2 lymphadenectomy has become increasingly accepted in high-volume Eastern centers. However, concerns remain regarding the adequacy of nodal dissection and long-term oncological safety, particularly in advanced gastric cancer.

Materials and Methods: 246 Patients who underwent laparoscopic subtotal or total gastrectomy with D2 lymphadenectomy between 2012 and 2022 were analyzed. Demographic, perioperative, and pathological variables were collected. Outcomes included lymph node yield, complications, margin status, overall survival (OS), and disease-free survival (DFS). The impact of indocyanine green (ICG) fluorescence mapping and robotic assistance was evaluated.

Results: Of 246 patients, 162 (65.8%) underwent laparoscopic subtotal gastrectomy and 84 (34.2%) underwent total gastrectomy. The mean number of retrieved lymph nodes was 37.8±9.4, with 100% adequacy. The 30-day mortality was 1.6%, and major complications occurred in 12.6%, with anastomotic leakage in 3.6%. R0 resection was achieved in 94.3% of patients. At a median follow-up of 46 months, 5-year OS and DFS were 58.7% and 52.1%, respectively. In 72 patients with ICG-guided lymphadenectomy, nodal yield increased to 41.6, and robotic assistance (28 patients) was associated with lower morbidity and shorter hospital stay.

Conclusion: Laparoscopic gastrectomy with D2 lymphadenectomy is feasible, safe, and oncologically adequate in high-volume centers. Technical innovations such as ICG fluorescence mapping and robotic assistance enhance surgical precision and may further improve outcomes.

Keywords: D2 lymphadenectomy, gastric cancer, laparoscopic gastrectomy

Introduction

Gastric cancer remains one of the leading causes of cancer-related mortality worldwide, despite improvements in diagnosis and therapy.[1] Its incidence has declined in Western countries but continues to be highly prevalent in East Asia, especially in Japan, Korea, and China, where organized screening and advanced surgical techniques are routine.[2] Radical gastrectomy with D2 lymphadenectomy is considered the standard treatment for resectable gastric cancer, particularly for stage IB–III disease, and is endorsed by the Japanese Gastric Cancer Association (JGCA).[3] Historically, D2 dissection was associated with increased morbidity and mortality in Western trials, but refinements in perioperative management and technical expertise in Eastern centers have substantially improved its safety.[4]

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The introduction of laparoscopy into gastric cancer surgery marked a major step forward in the last two decades.[5] Large randomized controlled trials and meta-analyses from Korea and Japan demonstrated that laparoscopic distal gastrectomy provides equivalent oncological outcomes compared with open surgery, while offering benefits such as less blood loss, reduced pain, and faster recovery.[6,7] Initially, applying laparoscopy to advanced gastric cancer requiring D2 lymphadenectomy was controversial due to concerns regarding technical complexity and adequacy of nodal retrieval.[8] However, accumulating evidence has shown that laparoscopic D2 dissections consistently achieve sufficient lymph node yields, often exceeding 35 nodes, which meets international oncological standards.[9]

In recent years, laparoscopic total gastrectomy has also been validated, with long-term survival outcomes equivalent to open approaches.[10] These advances were made possible by growing surgical experience and the development of adjunctive technologies. Among them, indocyanine green (ICG) fluorescence imaging has emerged as a promising tool for real-time lymphatic mapping, enabling more precise and complete nodal dissection.[11] Prospective studies from Japan and Korea have shown that ICG-guided lymphadenectomy increases the number of retrieved lymph nodes and improves staging accuracy.[12] Another innovation is robotic-assisted gastrectomy, which provides enhanced dexterity, tremor filtration, and three-dimensional visualization.[13] Robotic systems have been associated with reduced blood loss, better ergonomics, and potentially fewer complications, though cost and accessibility remain limitations.[14]

Against this background, the present study aimed to evaluate the perioperative safety, oncological adequacy, and long-term outcomes of laparoscopic gastrectomy with D2 lymphadenectomy in a large consecutive series of 246 patients. We further analyzed the impact of technical innovations such as ICG-guided fluorescence mapping and robotic assistance on nodal retrieval, complications, and survival.

Materials and Methods

This retrospective cohort study was conducted at a tertiary referral center between January 2012 and December 2022. A total of 246 patients who underwent laparoscopic gastrectomy with D2 lymphadenectomy for histologically confirmed gastric adenocarcinoma were included. The study was approved by the institutional ethics committee, and informed consent was obtained from all patients.

Patient Selection

Inclusion criteria were:

Age ≥18 years,

Diagnosis of gastric adenocarcinoma confirmed by preoperative endoscopic biopsy,

No evidence of unresectable or metastatic disease at the time of surgery (except limited peritoneal implants amenable to resection in selected stage IV cases),

Completion of a laparoscopic subtotal or total gastrectomy with curative intent and standard D2 lymphadenectomy.

Exclusion criteria were:

Emergency surgery for bleeding or perforation,

Palliative bypass procedures without resection,

Patients with incomplete clinical or pathological data.

Preoperative Evaluation

All patients underwent standard staging work-up, including upper gastrointestinal endoscopy, computed tomography (CT) of the chest and abdomen, and in selected cases, positron emission tomography (PET-CT). Staging laparoscopy was performed when peritoneal dissemination was suspected. Preoperative comorbidities were documented and classified according to the American Society of Anesthesiologists (ASA) physical status score and Eastern Cooperative Oncology Group (ECOG) performance status. The ASA physical status classification and ECOG performance status were recorded according to standard definitions. The extent of gastrectomy and lymphadenectomy was defined in accordance with the Japanese Gastric Cancer Association (JGCA) guidelines.

Surgical Technique

All procedures were performed laparoscopically by experienced surgical teams specialized in minimally invasive gastric surgery. Subtotal gastrectomy was performed in 162 patients (65.8%), and total gastrectomy in 84 patients (34.2%). Standard D2 lymphadenectomy was carried out in accordance with the Japanese Gastric Cancer Association (JGCA) guidelines, including systematic dissection of perigastric and extraperigastric nodal stations (No. 1–12). Reconstruction was achieved using either a linear stapled or hand-sewn technique for gastrojejunostomy or esophagojejunostomy.

In the last 72 patients, indocyanine green (ICG)-guided fluorescence imaging was utilized for intraoperative lymphatic mapping to enhance nodal retrieval. Additionally, 28 patients (11.4%) underwent robotic-assisted laparoscopy, integrated into the treatment protocol during the later study period.

Neoadjuvant chemotherapy was administered in patients with clinically stage II or higher disease according to the institutional multidisciplinary board recommendation, typically using a platinum–fluoropyrimidine–based doublet regimen. Adjuvant chemotherapy was considered for pathologic stage II–III disease, following current international guidelines

Data Collection

Demographic characteristics (age, sex, body mass index [BMI]), ASA and ECOG scores, tumor location, histological subtype, operative details (operation time, blood loss, conversion rate), pathological findings (tumor stage, T and N classification, number of retrieved and metastatic lymph nodes, resection margin status), and perioperative complications were recorded. Postoperative complications were graded according to the Clavien–Dindo classification, and anastomotic leakage, intraabdominal abscess, bleeding, and pulmonary complications were analyzed separately.

Outcome Measures

The primary outcomes were the number of lymph nodes retrieved, the radicality of resection (R0/R1), and postoperative morbidity and mortality. Secondary outcomes included disease-free survival (DFS) and overall survival (OS), calculated from the date of surgery to recurrence, death, or last follow-up. Survival analyses were performed using the Kaplan–Meier method. Recurrence was evaluated using a combination of clinical assessment, tumor marker monitoring, and imaging studies (contrast-enhanced CT or PET-CT). The diagnosis of recurrence was confirmed based on radiologic and/or clinical findings consistent with disease progression

Statistical Analysis

All data were analyzed using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean±standard deviation (SD) or median (range), and categorical variables as frequencies and percentages. The chi-square or Fisher's exact test was used for categorical variables, and the Student's t-test or Mann–Whitney U test for continuous variables, as appropriate. Survival outcomes were compared using the log-rank test, and multivariate analyses were performed with the Cox proportional hazards model. A p-value <0.05 was considered statistically significant.

Ethical Approval

This study was approved by the Ethics Committee of Erzurum City Hospital (No: 2025/03-159, Date: 11/03/2025). All procedures were conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments.

Results

A total of 246 patients who underwent laparoscopic gastrectomy with D2 lymphadenectomy were analyzed. The median follow-up period was 46 months (range, 12–118 months).

Patient Characteristics

Of the patients, 158 (64.2%) were male and 88 (35.8%) were female, with a mean age of 61.4±10.8 years (range, 33–82 years). The mean body mass index (BMI) was 24.5±3.2 kg/m². According to the ASA classification, 54 patients (22.0%) were ASA I, 113 (46.0%) ASA II, 94 (38.2%) ASA III, and 20 (8.1%) ASA IV. ECOG performance status was 0 in 54 patients (22.0%), 1 in 118 (48.0%), 2 in 62 (25.2%), and 3 in 12 (4.9%). The majority of patients (72.4%) had at least one comorbidity, most frequently hypertension and diabetes mellitus (Table 1).

Table 1. Patient Characteristics

Variable	Value
Total patients	246
Male	158 (64.2%)
Female	88 (35.8%)
Mean age (years)	61.4±10.8
Mean BMI (kg/m²)	24.5±3.2
ASA I/II/III/IV	54/113/94/20
ECOG 0/1/2/3	54/118/62/12

Tumor Characteristics

Tumor localization was in the antrum/corpus in 134 cases (54.4%), proximal stomach/cardia in 76 (30.9%), and diffuse or whole-stomach involvement in 36 (14.6%). Histologically, intestinal-type adenocarcinoma was predominant (158 patients, 64.2%), followed by diffuse type (74 patients, 30.1%) and mixed type (14 patients, 5.7%).

Pathological staging according to the AJCC 8th edition revealed stage I disease in 46 patients (18.7%), stage II in 82 (33.3%), stage III in 98 (39.8%), and stage IV in 20 patients (8.1%). Most stage IV patients had limited peritoneal implants or positive cytology, and all underwent resection with curative intent.

Operative Outcomes

A total of 162 patients (65.8%) underwent laparoscopic subtotal gastrectomy and 84 patients (34.2%) laparoscopic total gastrectomy. The mean operative time was 242±48 minutes (range, 180–370 min), significantly longer in total gastrectomy cases ($p<0.05$). The mean estimated blood loss was 178±65 ml, also higher in total gastrectomy ($p<0.05$).

Conversion to open surgery was required in 14 patients (5.6%), primarily due to uncontrolled bleeding (n=6), dense adhesions (n=5), or technical difficulty in advanced tumors (n=3) (Table 2).

Lymph Node Dissection

A complete D2 lymphadenectomy was achieved in all cases. The mean number of retrieved lymph nodes was 37.8±9.4 (range, 28–62), and adequate nodal harvest (>15 nodes) was 100%. The mean number of metastatic lymph nodes was 4.2±3.6.

In the subgroup of 72 patients who underwent ICG-guided fluorescence lymphatic mapping, the mean number of retrieved nodes increased to 41.6±8.7, which was statistically higher compared with the conventional group ($p=0.021$). Furthermore, the nodal upstaging rate (detection of additional positive nodes) was slightly higher in the ICG group ($p=0.07$).

Postoperative Morbidity and Mortality

The 30-day postoperative mortality was 1.6% (n=4). Major postoperative complications (Clavien–Dindo ≥ III) occurred in 31 patients (12.6%). The most frequent severe complication was anastomotic leakage (n=9, 3.6%), followed by intraabdominal abscess (7, 2.8%), pulmonary complications (6, 2.4%), postoperative bleeding (5, 2.0%), and other causes (4, 1.6%) (Table 3, Fig. 1).

The mean hospital stay was 9.4±3.2 days (range, 6–24 days). Patients with major complications had significantly longer hospital stays ($p<0.001$). Reoperation was required in 8 patients (3.2%), mainly for leakage or bleeding.

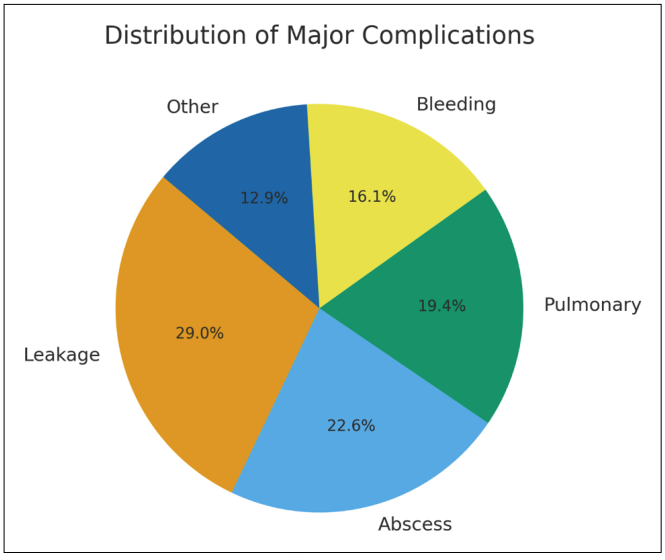

Figure 1. Distribution of Major Postoperative Complications.

Table 2. Operative Outcomes

Variable	Value
Subtotal gastrectomy	162 (65.8%)
Total gastrectomy	84 (34.2%)
Mean operative time (min)	242±48
Mean blood loss (ml)	178±65
Conversion to open surgery	14 (5.6%)

Table 3. Postoperative Complications

Complication	n (%)
Anastomotic leakage	9 (3.6)
Intraabdominal abscess	7 (2.8)
Pulmonary complication	6 (2.4)
Bleeding	5 (2.0)
Other	4 (1.6)
Total major morbidity	31 (12.6)
30-day mortality	4 (1.6)

Pathological and Margin Status

R0 resection was achieved in 232 patients (94.3%), whereas R1 margins were observed in 14 patients (5.7%), mostly in those with T4b or stage IV tumors. The rate of R0 resection was significantly lower in advanced-stage disease (p=0.003).

Oncological Outcomes

The median follow-up was 46 months. The 3-year overall survival (OS) rate was 71.2%, and the 5-year OS was 58.7%. The 3-year disease-free survival (DFS) rate was 66.4%, and the 5-year DFS was 52.1% (Fig. 2).

When analyzed by stage, 5-year OS was 92.3% for stage I, 71.8% for stage II, 44.9% for stage III, and 22.1% for stage IV (p<0.001, log-rank test) (Fig. 3). Patients with ICG-guided lymphadenectomy demonstrated a non-significant trend toward improved DFS at 3 years (p=0.09).

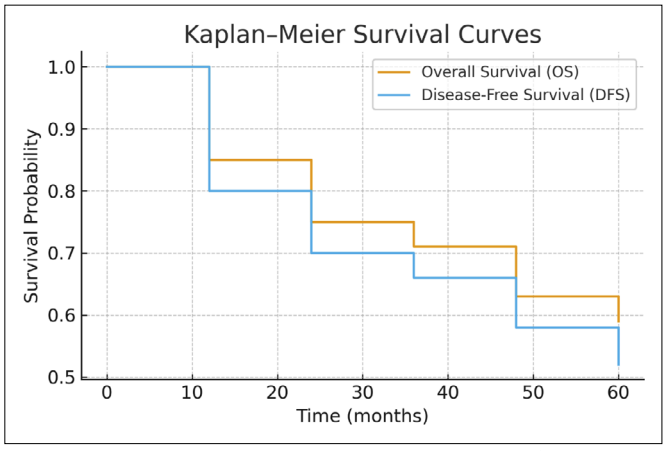

Figure 2. Kaplan–Meier Survival Analysis for Overall and Disease-Free Survival.

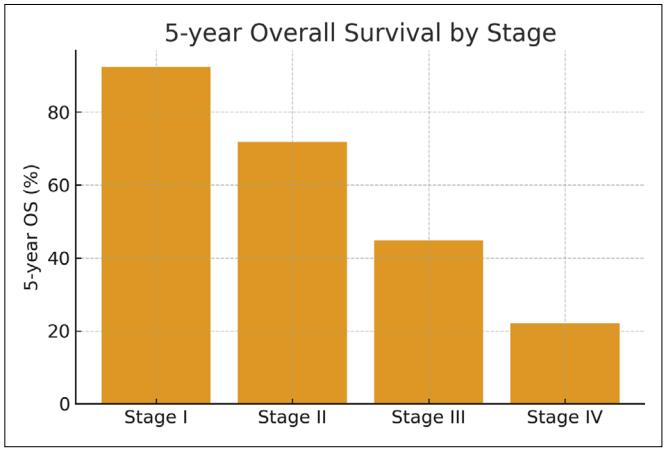

Figure 3. Five-Year Overall Survival Rates According to Pathological Stage.

Subgroup analysis revealed that patients undergoing robotic-assisted laparoscopy (n=28) had a lower rate of major complications (7.1% vs 13.4%, p=0.12) and a shorter median hospital stay (7 vs 10 days, p=0.04) compared with conventional laparoscopy.

Discussion

This study of 246 patients demonstrated that laparoscopic gastrectomy with D2 lymphadenectomy is both feasible and oncologically safe when performed in a high-volume Eastern center. The mean number of retrieved lymph nodes was 37.8, which exceeds the international benchmark of 15 nodes and is comparable to outcomes from Korean and Japanese multicenter trials.[6,9] Adequate nodal clearance is a critical determinant of staging accuracy and long-term prognosis, and our results confirm that laparoscopic approaches can meet oncological standards.

Perioperative outcomes were favorable. The conversion rate to open surgery was 5.6%, which is consistent with recent Eastern series reporting rates of 3–8%.[7,9] Major complications occurred in 12.6% of patients, with anastomotic leakage in 3.6%, intraabdominal abscess in 2.8%, pulmonary complications in 2.4%, and postoperative bleeding in 2.0%. These outcomes closely mirror complication rates reported in large-scale Korean and Japanese studies.[10,12] The 30-day mortality of 1.6% is also within the acceptable range for gastric cancer surgery and demonstrates the safety of laparoscopic D2 procedures in experienced hands.[15,16]

Long-term outcomes were encouraging. The five-year overall survival rate was 58.7%, and the five-year disease-free survival rate was 52.1%. When stratified by stage, survival reached over 90% for stage I, about 72% for stage II, 45% for stage III, and 22% for stage IV, which is consistent with published Eastern cohorts.[5,10,17] These results demonstrate that laparoscopic D2 gastrectomy does not compromise long-term oncological efficacy compared with open surgery.

An important finding in our study was the benefit of ICG fluorescence mapping. In the subgroup of 72 patients who underwent fluorescence-guided lymphadenectomy, the mean nodal yield increased significantly to 41.6. This result aligns with reports from Japanese and Korean groups, which demonstrated that ICG facilitates identification of lymphatic channels and improves lymph node harvest.[18,19] Although our study was not powered to assess survival differences, a trend toward improved disease-free

survival was observed in the ICG group, suggesting that enhanced nodal clearance may translate into oncological benefits, a finding that has also been noted in other Eastern prospective trials.[20]

Robotic-assisted surgery was performed in 28 patients and was associated with fewer major complications and shorter hospital stays compared with conventional laparoscopy. Although the differences did not reach statistical significance, the trend is consistent with recent multicenter Korean analyses showing that robotic gastrectomy reduces intraoperative blood loss and may lower anastomotic leakage rates.[21,22] Nonetheless, the cost-effectiveness of robotic approaches remains uncertain, and their availability is limited to specialized centers.[23]

Our results emphasize the importance of surgical expertise, institutional experience, and multidisciplinary care in achieving favorable outcomes with laparoscopic D2 gastrectomy. The learning curve for total gastrectomy and advanced D2 dissections is steep, but with adequate case volume and training, outcomes comparable to open surgery can be achieved.[7,24] These findings are highly relevant for global practice, as Western adoption of minimally invasive D2 gastrectomy has been slower, partly due to lower gastric cancer incidence and differences in surgical training.[2,25]

The strengths of our study include its relatively large sample size, standardized surgical technique, and comprehensive follow-up, which provide robust long-term data. Furthermore, the integration of fluorescence and robotic innovations offers valuable insights into the future of gastric cancer surgery. However, certain limitations should be acknowledged. The retrospective design introduces the possibility of selection bias, and the absence of a contemporaneous open surgery control group limits direct comparison. Additionally, while survival outcomes were promising, larger randomized trials are needed to validate the oncological equivalence of laparoscopic D2 gastrectomy across diverse patient populations.[8,21]

Conclusion

In conclusion, laparoscopic gastrectomy with D2 lymphadenectomy is a safe and effective treatment for gastric cancer in high-volume centers. Adequate lymph node yields, acceptable complication rates, and favorable survival outcomes support its role as a standard surgical option. Technical innovations such as ICG fluorescence mapping and robotic assistance further enhance surgical precision and may improve patient outcomes. Future multicenter prospective studies are necessary to confirm these findings and establish cost-effective strategies for integrating new technologies into routine practice.

Disclosures

Ethics Committee Approval: This study was approved by the Ethics Committee of Erzurum City Hospital (No: 2025/03-159, Date: 11/03/2025).

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Original Article

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Three-dimensional vs. two-dimensional laparoscopic approach in donor nephrectomy: A prospective randomized study

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ABSTRACT

Introduction: This prospective randomized study aimed to compare the effectiveness and outcomes of three- dimensional (3D) versus two-dimensional (2D) laparoscopic systems in donor nephrectomy.

Materials and Methods: A total of 25 laparoscopic donor nephrectomy cases, which were performed between March 30, 2022, and January 12, 2023, were randomized into 2D and 3D groups. Donor demographics, perioperative data, postoperative complications, pain scores, hospital stay, and graft function up to 18 months were evaluated.

Results: No significant differences were observed between the 2D (n=12) and 3D (n=13) groups regarding donor characteristics, operative time, warm ischemia time, complication rates, transfusion requirements, postoperative pain, or length of hospital stay. Although multiple renal vessels were more frequent in the 2D group (p=0.039), this did not affect overall outcomes. Postoperative kidney function remained comparable in both groups. The use of 3D systems did not result in statistically significant improvements in surgical metrics but may provide enhanced depth perception.

Conclusion: While 3D laparoscopy may improve depth perception and spatial orientation, this study did not demonstrate statistically significant advantages over 2D systems in donor nephrectomy outcomes. Larger, multicenter studies are needed to further assess the clinical impact of 3D laparoscopy in this setting.

Keywords: Laparoscopic donor nephrectomy, laparoscopic systems, living donor nephrectomy, three-dimensional renal transplantation

Introduction

Conventional two-dimensional (2D) laparoscopy systems have limitations, including reduced depth perception and restricted spatial orientation.[1] In contrast, three-dimensional (3D) laparoscopy systems provide stereoscopic vision by integrating different images captured by each eye to create a perception of depth.[1] This study aimed to compare conventional 2D laparoscopy with 3D laparoscopy in donor nephrectomy.

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Materials and Methods

In this prospective randomized study, 25 donor nephrectomy cases were allocated using a computer-based system (Research Randomizer), which employs the "Math. random" function in JavaScript. The study was conducted between March 30, 2022, and January 12, 2023. Donor nephrectomy cases performed using laparoscopic techniques were included, whereas cases performed with open techniques were excluded. The following data were recorded: Donor age, sex, comorbidities, smoking history, surgical history, body mass index (BMI), presence of multiple graft vessels, side of donation, number of trocars used during surgery, operative time, warm ischemia time, drain usage, transfusion requirement, conversion to laparotomy, reoperation, intraoperative and/or early postoperative complications (within the first postoperative week), early visual analog scale (VAS), duration of parenteral analgesic use, and length of hospital stay. Complica- tions observed within eighteen months postoperatively were also recorded. Surgeries were performed by five dif- ferent surgeons.

Data were analyzed using SPSS 17.0 for Windows. Continuous variables were presented as mean±SD, while categorical variables were presented as percentages. The Shapiro-Wilk test was used to assess normality. Chi-square or Fisher's Exact Test was used for categorical variables. Student's t-test was applied for normally distributed continuous variables, and the Mann-Whitney U test was used for non-normally distributed variables. A p-value of <0.05 was considered statistically significant.

Ethical approval was obtained from the Inönü University Ethics Committee (No:2019/104, Date: 22/05/2019) as part of a scientific research project (BAP, Project code: TSG-2020-1884) and the study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

Of the 32 kidney transplants performed, 28 (87.5%) utilized grafts from living donors. While three donor nephrectomies (10.71%) were performed using the open technique due to anatomical considerations identified by the surgeons, 25 (89.28%) were performed laparoscopically. The mean age of donors was 49.08 ± 13.21 years (13 males, 12 females). Only two donors had a history of previous abdominal surgery.

The mean age of donors was 49.08±13.21 years (13 male, 12 female). Only two had a history of previous abdominal surgery. Comorbidities included pseudothrombocytopenia (n=1), chronic obstructive pulmonary disease (n=1), diabetes mellitus (n=1), and scoliosis (n=1). Twelve donors reported a history of smoking. The mean BMI was 27.9±4.6.

Of the 25 laparoscopic cases, 13 were performed us- ing 3D laparoscopy and 12 using 2D laparoscopy. Twelve cases used 3 trocars, another 12 used 4 trocars, and one case used 5 trocars. The mean warm ischemia time was 184.92 ± 62.34 seconds, and the mean total operative time was 265.44 ± 49.5 minutes. None of the cases required conversion to laparotomy. Two patients underwent laparotomy on postoperative day 1 due to hemorrhage and received blood transfusions. One patient required a transfusion on postoperative day 3 due to anemia. Surgical drains were placed in 7 patients. One patient required re- catheterization for urinary retention. Two patients received antibiotics for positive urine culture. One patient was diagnosed with COVID-19 on postoperative day 5 and was discharged on day 13. The highest reported VAS score was 4.72 ± 1.24. The mean duration of parenteral analgesia was 3.44 ± 1.75 days. Fifteen patients received tramadol hydrochloride in addition to paracetamol for pain management. The mean hospital stay was 6.28 ± 1.92 days.

No significant differences were observed between the two groups regarding age (p=0.301), sex (p=0.277), or BMI (p=0.502). No significant difference was found in graft laterality (p=0.672), although multiple vessels in the graft were more common in the 2D group (p=0.039). No significant differences were observed in warm ischemia time (p=0.886) or total operative time (p=0.683). No significant differences were found between the groups regarding conversion to open surgery, reoperation (p=0.74), transfusion requirement (p=0.531), use of additional trocars (p=0.157), drain placement (p=0.45), or infections (p=0.328). The highest VAS score, duration of parenteral analgesia, tramadol requirement, and length of hospital stay were also statistically similar (p=0.388, p=0.536, p=0.404, and p=0.798, respectively). No significant differences were found in postoperative creatinine levels at 1, 6, and 18 months (p=0.65, p=0.556, and p=0.656). The incidence of incisional hernia was not statistically significant (p=0.109) (Table 1).

There were no deaths, except for a 58-year-old female patient who died due to the Kahramanmaraş earthquake on February 6, 2023, unrelated to donor nephrectomy.

Table 1. Donor characteristics according to 2D laparoscopy and 3D laparoscopy methods

Characteristics	Laparoscopy method		p
	2D	3D	
Age	51.58±15.1	46.76±11.29	0.301
Gender, n (%)			
Male	5 (41.7)	8 (61.5)	0.277
Female	7 (58.3)	5 (38.5)	
Body mass index	28.55±3.76	27.3±5.37	0.502
Smoking, n (%)			
No	8 (66.7)	5 (38.5)	0.157
Yes	4 (33.3)	8 (61.5)	
Graft side, n (%)			
Left	10 (83.3)	11 (84.6)	0.672
Right	2 (16.7)	2 (15.4)	
Multiple vessels in graft, n (%)			
No	8 (66.7)	13 (100)	0.039
Yes	4 (33.3)	-	
Number of trocars, n (%)			
3	4 (33.3)	8 (61.5)	0.157
>3	8 (66.7)	5 (38.5)	
Warm ischemia time	186.83±63.20	183.15±64	0.886
Operative time	261.5±47.17	269±53.22	0.683
Drain usage, n (%)			
No	8 (66.7)	10 (76.9)	0.45
Yes	4 (33.3)	3 (23.1)	
Transfusiıon, n (%)			
No	11 (91.7)	11 (84.6)	0.531
Yes	1 (8.3)	2 (15.4)	
Reoperation, n (%)			
No	11 (91.7)	12 (92.3)	0.74
Yes	1 (8.3)	1 (7.7)	
Infection, n (%)			
No	11 (91.7)	10 (76.9)	0.328
Yes	1 (8.3)	3 (23.1)	
Visual analog scale (highest)	4.5±0.9	4.92±1.49	0.388
Analgesia requirement (day)	3.4±1.3	3.46±2.14	0.536
Tramadol hydrochloride, n (%)			
No	4 (33.3)	6 (46.2)	0.404
Yes	8 (66.7)	7 (53.8)	
Hospital stay (day)	6.7±2.59	5.84±0.89	0.798
Incisional hernia, n (%)			
No	8 (66.7)	12 (92.3)	0.109
Yes	4 (33.3)	1 (7.7)	
Postoperative creatinine value (28 day)	1.26±0.24	1.22±0.22	0.650
Postoperative creatinine value (6 month)	1.12±0.2	1.18±0.14	0.556
Postoperative creatinine value (18 month)	1.16±0.32	1.1±0.27	0.656

Discussion

There are few studies comparing conventional 2D and 3D laparoscopy systems.[1-10] In studies on laparoscopic chole-cystectomy, there is no strong evidence demonstrating the superiority of 3D laparoscopy,[4,5] possibly due to the technical limitations at the time 3D systems were first introduced.[1,4,5]

A meta-analysis comparing outcomes of gastrointestinal cancer surgeries found that 3D laparoscopy did not show superiority over 2D in colorectal cancer, but did reduced operative time and intraoperative bleeding in gastric cancer surgeries.[6] No significant differences were observed in lymph node dissection or postoperative complications.[6] Similarly, in cervical cancer surgeries, 3D laparoscopy reduced operative time and blood loss without affecting complication rates or lymph node counts.[7]

Some studies on urological surgeries were conducted in laboratory settings with trainees.[8] In surgeries performed by a single surgeon, including pyeloplasty, simple and radical nephrectomy, 3D laparoscopy was superior in terms of total operative time, dissection and suturing time, and blood loss, although no differences were observed in complications, postoperative pain, or hospital stay.[1] A meta-analysis including pyeloplasty, partial nephrectomy, and radical prostatectomy showed that 3D laparoscopy shortened warm ischemia time and reduced blood loss in radical prostatectomy, but no significant differences were observed in partial nephrectomy.[9]

Donor nephrectomies must prioritize donor safety, distinguishing them from other types of nephrectomy. Preserving graft function further increases the complexity of the procedure. Only two studies specifically focused on donor nephrectomy.[10,11] In one study of 38 patients, all underwent hand-assisted left nephrectomy, with 3D laparoscopy (n=19) demonstrating shorter operative and warm ischemia times, reduced blood loss, and shorter hospital stay, but no difference in complication rates or renal function.[10] Another study with 73 patients (n=16, 3D laparoscopy) showed similar findings.[11]

This study did not demonstrate statistically significant differences in surgical outcomes compared to conventional 2D systems in donor nephrectomy. Although cases performed with 3D laparoscopy showed shorter warm ischemia time, operative time, and hospital stay, these differences were not statistically significant. Drain usage was lower, and transfusion requirement higher in the 3D group, whereas the reoperation rate was lower; however, none of these differences reached statistical significance. The highest VAS scores were slightly higher in the 3D group, and more trocars were required in the 2D group due to higher prevalence of multiple vessels; nevertheless these differences were not statistically significant. Unlike previous studies, these differences may be attributed to the involvement of more surgeons, their extensive experience with 2D laparoscopy, or the relatively small sample size. Consistent with previous research, we found that postoperative kidney function was not affected by the type of laparoscopic system. Nevethless, the small sample sizes remain a limitation.

This study was not designed to evaluate surgeons' perceptions of laparoscopy systems. Although all five surgeons re- ported improved depth perception with 3D systems, more standardized, multicenter studies are necessary for objective conclusions.

Conclusion

Enhancing depth perception and orientation in laparoscopic systems is critical for surgical success. Although 3D laparoscopic systems offer improved visualization, our study did not demonstrate statistically significant differences in surgical outcomes compared to conventional 2D systems in donor nephrectomy. Considering the high level of surgeon experience and the limited sample size, these findings should be interpreted with caution.

Further multicenter studies with larger sample sizes, including assessments of surgeon ergonomics and learning curves, are needed to better define the potential benefits of 3D laparoscopy in living donor nephrectomy.

Disclosures

Ethics Committee Approval: Ethical approval was obtained from the Inönü University Ethics Committee (No:2019/104, Date: 22/05/2019) as part of a scientific research project (BAP, Project code: TSG-2020- 1884).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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T.P.; Literature Search – A.S., T.P.; Writing – A.S., T.P.; Critical Review – A.S., S.U., E.K., G.O., F.O., F.S., S.M.D., T.P., C.K.

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LESS

Original Article

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Early rehabilitation after laparoscopic surgery translates into timely adjuvant chemotherapy for colorectal and gastric cancer

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ABSTRACT

Introduction: The timing of adjuvant chemotherapy initiation is a critical determinant of oncologic outcomes in colorectal and gastric cancer. Delays beyond 6–8 weeks have been associated with inferior survival. Minimally invasive surgery and enhanced recovery protocols may facilitate earlier rehabilitation and timely initiation of systemic therapy.

Materials and Methods: We retrospectively analyzed 543 patients who underwent curative resection for colorectal (n=396) or gastric cancer (n=147) at Erzurum City Hospital between January 2022 and June 2025. Surgical approach (laparoscopic vs open), perioperative outcomes, Enhanced Recovery After Surgery (ERAS) adherence, complications, and the interval from surgery to adjuvant chemotherapy were assessed. The primary outcome was the initiation of chemotherapy within 6 weeks (≤42 days).

Results: Laparoscopic surgery was performed in 323 (59.5%) patients, while 220 (40.5%) underwent open surgery. ERAS adherence was significantly higher after laparoscopy (median 78 vs 67, p<0.001). Major complications (Clavien–Dindo≥II) occurred less frequently in laparoscopic cases (10.8% vs 25.0%). Median length of stay was shorter after laparoscopy (6.4 days vs 9.3 days, p<0.001). Among 370 patients who received adjuvant chemotherapy, the median time-to-chemo was 30 days after laparoscopy versus 39 days after open surgery (p<0.001). The proportion initiating chemotherapy within 6 weeks was significantly higher in the laparoscopic group (94% vs 66%, p<0.001). In multivariable analysis, open surgery (OR 0.20, 95% CI 0.09–0.43, p<0.001) and major complications (OR 0.22, p<0.001) independently predicted failure to commence chemotherapy within 6 weeks.

Conclusions: Laparoscopic surgery for colorectal and gastric cancer was associated with higher ERAS adherence, lower morbidity, shorter hospital stay, and earlier initiation of adjuvant chemotherapy compared with open surgery. These findings highlight the importance of minimally invasive approaches and structured perioperative care in optimizing oncologic treatment timelines.

Keywords: Colorectal cancer, Gastric cancer, Laparoscopic surgery

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Introduction

Colorectal and gastric cancers remain among the most common malignancies worldwide and are associated with significant morbidity and mortality despite advances in diagnosis, surgical techniques, and systemic therapies.[1,2] Surgery is the cornerstone of treatment in localized disease, yet the risk of recurrence persists, especially in stage II–III tumors. Therefore, adjuvant chemotherapy has become an essential component of multimodal treatment, aiming to eradicate micrometastatic disease, reduce recurrence rates, and improve long-term survival outcomes.[3] The timing of adjuvant therapy initiation is critical, as delayed commencement has been repeatedly associated with inferior survival and diminished therapeutic efficacy.[4,5]

Several large cohort studies and meta-analyses have demonstrated that postponing chemotherapy beyond 6–8 weeks after curative resection significantly decreases disease-free and overall survival in both colorectal and gastric cancers.[6–8] Consequently, international guidelines recommend that adjuvant therapy should ideally be initiated within 6 weeks following surgery.[9] However, achieving this benchmark is often challenging in clinical practice, as patient recovery, postoperative complications, and institutional factors contribute to variability in treatment initiation.[10]

In recent years, minimally invasive surgical approaches, particularly laparoscopic techniques, have gained prominence in gastrointestinal oncology. Laparoscopic surgery is associated with reduced surgical trauma, less intraoperative blood loss, decreased postoperative pain, earlier return of bowel function, and shorter length of hospital stay compared with conventional open surgery.[11,12] These advantages may facilitate faster functional recovery and allow earlier commencement of adjuvant chemotherapy. Moreover, the adoption of Enhanced Recovery After Surgery (ERAS) protocols has further reinforced the benefits of minimally invasive surgery by standardizing perioperative care and expediting rehabilitation.[13]

Despite these theoretical advantages, the real-world impact of laparoscopic surgery on the timing of adjuvant chemotherapy initiation remains underexplored. While several studies have suggested a shorter interval to chemotherapy after laparoscopy, findings are not entirely consistent across tumor sites, institutions, and patient populations.[14] In addition, the interplay between perioperative morbidity, ERAS adherence, and oncologic timelines has not been fully clarified.[15]

Given the prognostic implications of delayed chemotherapy and the widespread adoption of minimally invasive surgery, it is crucial to investigate whether surgical approach independently influences the timeliness of adjuvant therapy. Understanding these relationships may guide surgeons and oncologists in optimizing perioperative strategies and multidisciplinary care pathways to improve oncologic outcomes.[16]

Therefore, the present study aimed to compare laparoscopic and open surgery in terms of time to initiation of adjuvant chemotherapy in patients undergoing curative resection for colorectal and gastric cancer at a high-volume tertiary center. We hypothesized that the laparoscopic approach would be associated with higher ERAS adherence, lower morbidity, shorter hospital stay, and ultimately earlier initiation of adjuvant chemotherapy compared with open surgery.

Materials and Methods

Study Design and Setting

This retrospective cohort study was conducted at Erzurum City Hospital, Department of General Surgery, a tertiary referral center in eastern Türkiye. The study was approved by the local institutional ethics committee, and was performed in accordance with the principles of the Declaration of Helsinki. Patient confidentiality was maintained, and all data were anonymized before analysis.

Patient Population

We identified 543 consecutive patients who underwent curative-intent resection for colorectal or gastric adenocarcinoma between January 2022 and June 2025. Both elective and urgent oncologic resections were included, provided that the surgery was performed with curative intent and patients had available follow-up regarding initiation of adjuvant chemotherapy.

Inclusion criteria were:

- Histologically confirmed colorectal or gastric adenocarcinoma,
- Undergoing radical resection with either laparoscopic or open approach,
- Availability of complete perioperative and follow-up records.

Exclusion criteria were:

- Stage IV disease at presentation,

- Palliative resections or bypass procedures,
- Patients who died within 30 days postoperatively,
- Missing essential clinical or follow-up data.

Surgical Approach and Perioperative Care

Surgical approach (laparoscopic vs open) was determined according to tumor localization, patient comorbidities, and surgeon preference. Standard oncologic principles were applied for both techniques, including complete mesocolic excision for colon resections and D2 lymphadenectomy for gastric cancer.

Perioperative management followed institutional ERAS (Enhanced Recovery After Surgery) protocols, including preoperative nutritional optimization, early mobilization, multimodal analgesia, and early initiation of oral feeding whenever feasible. ERAS adherence was retrospectively assessed and scored on a composite 0–100 scale based on perioperative documentation.

Data Collection

Data were extracted from electronic medical records and operative reports. Variables included:

Demographics: Age, sex, body mass index (BMI), comorbidities (diabetes, hypertension, coronary artery disease, chronic kidney disease, chronic obstructive pulmonary disease), smoking history, ASA classification, ECOG performance status.

Perioperative details: Surgical approach, operative time, estimated blood loss, Clavien–Dindo classification of postoperative complications, length of hospital stay (LOS), readmission within 30 days, surgical site infection (SSI), prolonged postoperative ileus (PPOI), preoperative albumin, and postoperative day 3 C-reactive protein (CRP).

Pathology: Tumor site, pathological T and N categories, AJCC TNM stage, and resection margin status.

Oncologic treatment: Receipt of neoadjuvant therapy, initiation of adjuvant chemotherapy, time (days) from surgery to first chemotherapy cycle, and whether chemotherapy was commenced within 6 weeks (≤42 days).

Outcomes

The primary outcome was the interval from surgery to the initiation of adjuvant chemotherapy, expressed in days and dichotomized as ≤6 weeks or >6 weeks.

Secondary outcomes included ERAS adherence, length of stay, postoperative complications, readmission, and factors influencing timely initiation of chemotherapy.

Statistical Analysis

Continuous variables were tested for normality using the Shapiro–Wilk test. Normally distributed data were expressed as mean±standard deviation and compared using the Student's t-test, whereas non-normally distributed data were reported as median (interquartile range) and compared using the Mann–Whitney U test. Categorical variables were expressed as counts (percentages) and compared using the Chi-square test or Fisher's exact test where appropriate.

The impact of surgical approach and perioperative factors on timely chemotherapy (≤6 weeks) was evaluated using univariate analysis, followed by multivariable logistic regression including variables with $p<0.10$. Odds ratios (OR) and 95% confidence intervals (CI) were calculated.

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 28.0 (IBM Corp., Armonk, NY, USA). A two-tailed p value of <0.05 was considered statistically significant.

Results

Cohort and Baseline

We analyzed 543 patients who underwent curative-intent surgery for colorectal (n=396, 73.0%) or gastric cancer (n=147, 27.0%). The surgical approach was laparoscopic in 323 (59.5%) and open in 220 (40.5%) cases. Baseline characteristics and perioperative outcomes according to surgical approach are summarized in Table 1. The two groups were comparable in terms of age, sex distribution, and BMI, but differed significantly in terms of length of stay, complication rates, and time to chemotherapy.

Table 1. Summary by Surgical Approach

Approach	N	Median age	Median BMI	Median LOS	% Major Complications	N Chemo started	Median days to chemo	% Chemo within 6w
Laparoscopic	323	62.0	26.5	6.4	17.0	233	30.0	67.8
Open	220	64.0	26.2	9.2	37.3	137	39.0	40.9

Table 2. Cancer Type and Surgical Approach

Cancer type	Approach	N	Median LOS	% Major Complications	Median days to chemo	% Chemo within 6w
Colorectal	Laparoscopic	237	6.3	15.6	29.0	67.5
Colorectal	Open	159	9.4	37.7	40.0	40.3
Gastric	Laparoscopic	86	6.4	20.9	31.0	68.6
Gastric	Open	61	8.9	36.1	36.0	42.6

ERAS Adherence and Perioperative Outcomes

ERAS adherence was significantly higher in the laparoscopic group (median 78) compared with the open group (median 67). Perioperative outcomes showed favorable profiles for laparoscopy, with lower intraoperative blood loss, shorter median LOS (6.4 days vs 9.3 days, p<0.001), and reduced rates of major complications (Clavien–Dindo ≥II: 10.8% vs 25.0%) (Table 1). The distribution of complications by cancer type and surgical approach is shown in Table 2. Readmission within 30 days and SSI occurred less frequently after laparoscopy, though the difference did not reach statistical significance. Postoperative inflammatory response, measured by CRP on POD3, was lower in the laparoscopic cohort.

Initiation of Adjuvant Chemotherapy

Overall, 370/543 (68.1%) patients received adjuvant chemotherapy. The likelihood of receiving ACT was higher in the laparoscopic group (72.1%) compared with open surgery (62.3%, p=0.015) (Table 1). The median time to ACT was 32 days overall, but significantly shorter after laparoscopy (30 days) compared with open surgery (39 days, p<0.001). This difference is illustrated in the boxplot (Fig. 1) and further supported by the distribution histogram (Fig. 2). Importantly, the proportion of patients initiating ACT within 6 weeks was markedly higher after laparoscopy (94%) than open surgery (66%) (Table 1; Fig. 3).

When stratified by cancer type, both colorectal and gastric cancer patients benefited from laparoscopy with earlier initiation of ACT and higher rates of ≤6-week initiation (Table 2). In colorectal cancer, the median time-to-chemo was 29 days vs 40 days (laparoscopic vs open); in gastric cancer, 30 days vs 36 days, respectively.

Impact of Morbidity on Time-to-Chemo

Postoperative complications strongly influenced the timing of ACT. Patients with Clavien–Dindo ≥II complications started chemotherapy at a median of 39.5 days compared with 30 days in those without complications (p<0.001). Since the open group had higher rates of major morbidity, this partly mediated the observed delays in ACT in that cohort.

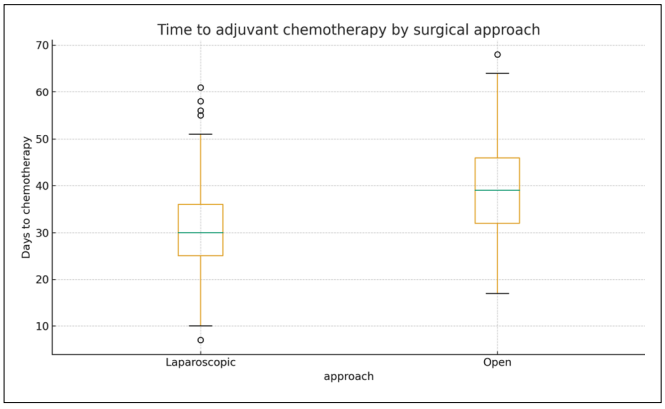

Figure 1. Boxplot illustrating the time from surgery to initiation of adjuvant chemotherapy according to surgical approach (laparoscopic vs open). Median time-to-chemotherapy was 30 days after laparoscopy versus 39 days after open surgery (p<0.001).

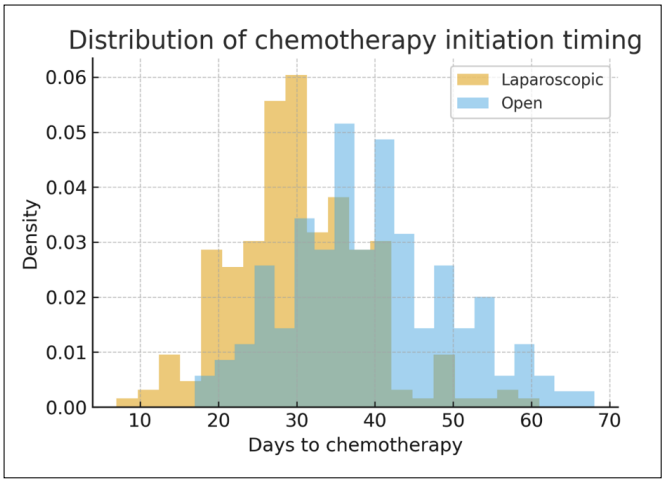

Figure 2. Histogram showing the distribution of adjuvant chemotherapy initiation timing in laparoscopic and open surgery groups. The distribution curve demonstrates earlier initiation in the laparoscopic cohort.

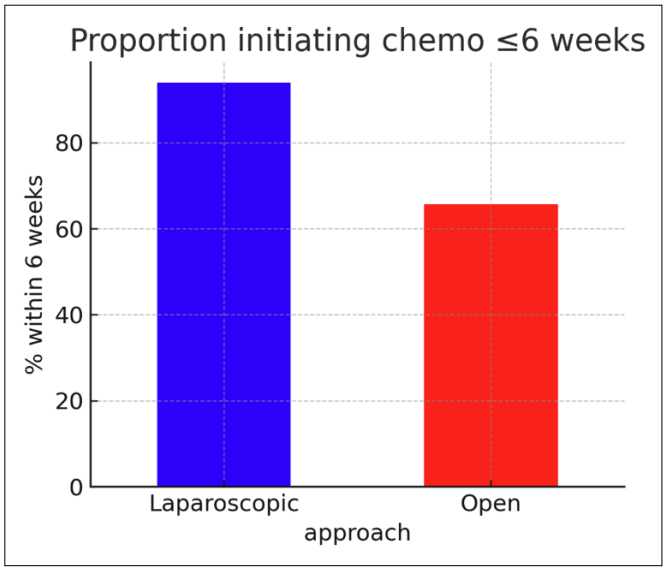

Figure 3. Bar chart demonstrating the proportion of patients who commenced adjuvant chemotherapy within 6 weeks of surgery. Initiation ≤6 weeks was achieved in 94% of laparoscopic versus 66% of open cases (p<0.001).

Multivariable Analysis

In an exploratory logistic regression restricted to patients who initiated ACT, open surgery (OR ≈0.20, 95% CI 0.09–0.43, p<0.001) and major complications (OR ≈0.22, p<0.001) were independently associated with failure to initiate chemotherapy within 6 weeks. Other factors, including ERAS score, ECOG, and preoperative albumin, were not significant predictors.

Discussion

In this retrospective cohort from a high-volume tertiary center, we demonstrated that laparoscopic surgery for colorectal and gastric cancers was associated with significantly earlier initiation of adjuvant chemotherapy compared with open surgery. The median time to chemotherapy was 9 days shorter after laparoscopy (30 vs 39 days), and the proportion of patients commencing therapy within 6 weeks was nearly 30% higher. These findings support the hypothesis that minimally invasive techniques, through their favorable perioperative profiles, can facilitate timely delivery of systemic therapy, which is critical for oncologic outcomes.

Our results align with previous population-based studies reporting that each 4-week delay in starting adjuvant therapy is associated with worse survival in colon cancer.[17] Several systematic reviews have confirmed that initiation beyond 8 weeks is consistently linked with decreased disease-free and overall survival.[18,19] In this context, our finding that more than 90% of laparoscopic cases achieved chemotherapy within 6 weeks is clinically meaningful. The enhanced adherence to ERAS protocols and reduced perioperative morbidity observed after laparoscopy likely explain this advantage.

Perioperative morbidity was an important determinant of chemotherapy delay in our series. Patients with Clavien–Dindo grade ≥II complications started adjuvant therapy nearly 10 days later compared with those without major morbidity. Similar observations have been made in large registry analyses, where postoperative complications accounted for the majority of treatment delays and negatively impacted long-term outcomes.[20,21] Importantly, the laparoscopic cohort in our study experienced fewer severe complications, reinforcing the indirect oncologic benefits of minimally invasive surgery.

Several randomized controlled trials and meta-analyses have compared laparoscopic and open approaches in gastrointestinal oncology. For gastric cancer, the KLASS-02 and CLASS-01 trials demonstrated non-inferiority of laparoscopy in terms of long-term survival while highlighting advantages in early recovery.[22,23] In colorectal cancer, the COLOR II and COREAN trials confirmed that laparoscopic surgery yields equivalent oncologic outcomes with shorter hospital stay and faster functional recovery.[24,25] However, few studies have directly examined the effect on adjuvant chemotherapy timing. A Japanese multicenter analysis reported that laparoscopic colectomy patients were more likely to receive chemotherapy within 8 weeks, echoing our findings.[26]

The role of ERAS pathways must also be emphasized. Evidence suggests that ERAS compliance is an independent predictor of faster recovery and reduced morbidity.[27] Our study incorporated an ERAS adherence score, which was significantly higher in the laparoscopic group, likely contributing to the observed acceleration in chemotherapy initiation. Other authors have similarly demonstrated that combining laparoscopy with structured ERAS programs maximizes the benefits of minimally invasive surgery.[28]

This study has several limitations that should be acknowledged. First, its retrospective single-center design may have introduced selection bias, as patients chosen for laparoscopic surgery might have had more favorable preoperative profiles. Second, although the dataset was comprehensive, certain confounders such as socioeco-

nomic factors or detailed oncologic regimens were not included. Third, long-term oncologic outcomes such as disease-free and overall survival were not analyzed, precluding a direct link between earlier chemotherapy and survival benefit.

Future studies should adopt prospective multicenter designs integrating detailed ERAS compliance metrics, patient-reported recovery outcomes, and survival endpoints. Furthermore, translational studies exploring biological mechanisms linking surgical stress response, systemic inflammation, and chemotherapy tolerance could deepen our understanding of how minimally invasive surgery contributes to improved oncologic timelines and outcomes.

Conclusion

In conclusion, laparoscopic surgery for colorectal and gastric cancer was associated with higher ERAS adherence, lower morbidity, shorter length of stay, and significantly earlier initiation of adjuvant chemotherapy compared with open surgery. These findings underscore the importance of integrating minimally invasive techniques and ERAS protocols to optimize perioperative recovery and oncologic timelines.

Disclosures

Ethics Committee Approval: The study was approved by the local institutional ethics committee, and was performed in accordance with the principles of the Declaration of Helsinki.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – A.D.; Design – M.T.; Supervision – D.O., A.D.; Funding – A.D.; Materials – M.T., D.O.; Data Collection – A.D., M.T.; Analysis and/or interpretation – M.T.; Literature Search – M.T.; Writing – A.D., M.T.; Critical Review – D.O., M.T., A.D.

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LESS

Case Report

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Entrapment of a nasogastric tube in the stapler line during laparoscopic sleeve gastrectomy: A case report

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ABSTRACT

Laparoscopic sleeve gastrectomy (LSG) is one of the most commonly performed bariatric procedures worldwide. Although generally safe, it is not without complications. We present a rare case of intraoperative entrapment of a nasogastric tube (NGT) in the stapler line during LSG, which resulted in a staple line leak. The complication was identified and managed intraoperatively. This case highlights the importance of communication between surgical and anesthesia teams, as well as meticulous intraoperative control.

Keywords: Bariatric surgery, nasogastric tube, sleeve gastrectomy, staple line leak, surgical complication

Introduction

Obesity is a multifactorial and complex disease resulting from the interaction between genetic and environmental factors.[1] Its prevalence continues to rise globally, making it a major public health concern.[2] When conservative methods fail, bariatric surgery becomes an effective and sustainable treatment option for morbid obesity. Bariatric procedures are classified into three main categories: Restrictive, malabsorptive, and combined techniques.[3-5] Among the restrictive options, laparoscopic sleeve gastrectomy (LSG) has gained widespread popularity due to its efficacy and relative technical simplicity.[6]

However, LSG is associated with potential complications, including infections, thromboembolic events, staple line leaks, strictures, respiratory issues, and technical mishaps such as entrapment of surgical instruments or devices like bougies or nasogastric tubes within the staple line.[7-11] Herein, we report a rare complication in which a nasogastric tube (NGT) was inadvertently stapled within the gastric sleeve, resulting in a leak, and we describe its intraoperative management.

Case Report

A 53-year-old female with a body mass index (BMI) of 39.6 kg/m² presented to our clinic with morbid obesity resistant to professional dietary interventions. Her medical history included type II diabetes mellitus and essential hypertension. After comprehensive preoperative evaluation, laparoscopic sleeve gastrectomy was planned.

Under general anesthesia, a 38F esophageal bougie was introduced orally for calibration. Starting 6 cm proximal to the pylorus, sleeve gastrectomy was performed using an Endo GIA stapler: Two green (4.1 mm), two gold (3.8 mm), and four blue (3.5 mm) cartridges were applied

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along the greater curvature, terminating near the angle of His. The resected stomach was extracted.

A routine intraoperative methylene blue test revealed a leak. Upon inspection, it was noted that the nasogastric tube (NGT), inserted preoperatively by the anesthesia team for gastric decompression, had not been removed and was inadvertently stapled within the resected gastric sleeve. The NGT was gently withdrawn. Examination of the specimen revealed that a portion of gastric tissue and the NGT tip were embedded in the staple line (Fig. 1). Upon opening the specimen (Fig. 2), a 2 cm defect was identified at the site of the leak. The gastric sleeve was repaired using a stapler by approximating the tissue margins.

The patient remained nil per os for two days postoperatively. A contrast study on postoperative day 2 showed no leak or stricture (Fig. 3), and oral intake was gradually resumed. The patient was discharged in stable condition. At her 4-month follow-up, she had lost 25 kg, with a BMI reduced to 30.1 kg/m². No further complications were observed during follow-up visits.

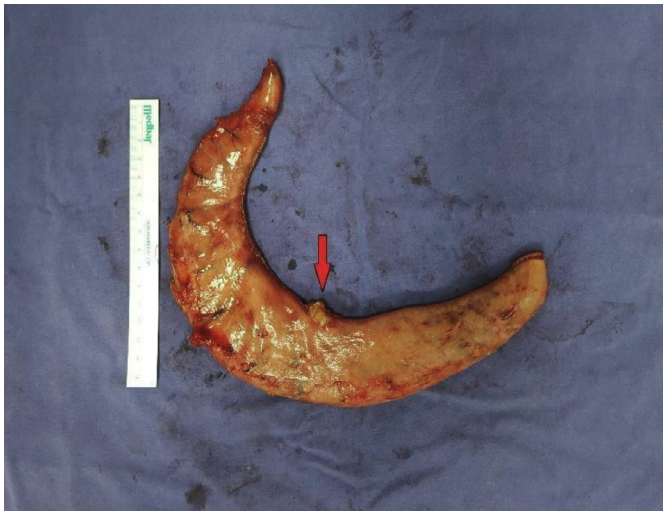

Figure 1. NGT tip in stapler line.

Figure 2. The used NGT was found to be shorter than the unused NGT.

Figure 3. A contrast study.

Discussion

Entrapment of devices such as bougies or nasogastric tubes (NGTs) within the staple line during laparoscopic sleeve gastrectomy (LSG) is a rare but preventable complication.

Intraoperative recognition of this issue allows for timely intervention and repair. Some surgeons advocate the use of intraoperative endoscopy to localize and assess the integrity of the staple line in such cases. In our case, the disruption in the staple line was clearly visualized laparoscopically after removal of the NGT, so endoscopic evaluation was deemed unnecessary.

One mechanism reported in similar cases is that the anesthesiologist may retract the NGT to the oropharynx prior to stapling, but during bougie insertion, the NGT may inadvertently advance back into the stomach and become trapped in the staple line.

Prompt recognition and management of complications in bariatric surgery are critical to minimizing morbidity and mortality. In our case, the patient was transferred to the ward with the NGT still in place postoperatively. The fol-

lowing day, it was removed by another physician assuming it was no longer needed. If the staple line disruption had not been recognized intraoperatively, this sequence of events could have led to a delayed leak and acute abdomen after resuming oral intake.

Conclusion

In laparoscopic bariatric procedures, ensuring removal of the nasogastric tube prior to stapling is essential to prevent serious complications. This requires clear communication between the surgical and anesthesia teams. Ultimately, the responsibility for tracking and verifying the presence and removal of all intraoperative devices should rest with the surgeon. To minimize risk, it may be advisable for the surgical team to be directly involved in both the insertion and removal of the nasogastric tube. Such vigilance can significantly reduce the likelihood of preventable complications.

Disclosures

Informed Consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

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