

A Totally Laparoscopic Colectomy is Feasible for Acute Complicated Appendicitis with Necrotic Appendiceal Base in the Emergency Setting

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Rezumat

Colectomia total laparoscopică este fezabilă în apendicita acută complicată cu necroză la nivelul bazei apendiculare în urgență

Introducere: Apendicita acută rămâne una dintre cele mai frecvente urgențe chirurgicale la nivel mondial. Apendicita acută complicată poate evolua către perforație sau gangrenă, implicând compromiterea bazei apendiculare. Această situație reprezintă o provocare pentru chirurg și poate necesita, în anumite cazuri, o rezecție ileo-colică. Scopul acestui studiu este de a demonstra avantajele și eficiența abordului minim invaziv în cazul apendicitei complicate care necesită rezecție ileo-colică.

Materiale și metode: Au fost analizați retrospectiv pacienții în cazul cărora s-a practicat rezecție extinsă pentru apendicită acută complicată în spitalul nostru, în perioada ianuarie 2022 - mai 2024. Au fost evaluate caracteristicile de bază, preoperatorii, intraoperatorii și postoperatorii ale pacienților.

Rezultate: Pe parcursul perioadei de studiu, 15 pacienți cu apendicită acută au necesitat rezecție laparoscopică extinsă. Dintre aceștia, 9 pacienți (56,2%) au necesitat rezecție ileocecală, iar 6 pacienți (43,8%) au necesitat colectomie dreaptă. Toți pacienții au beneficiat de anastomoză mecanică intracorporeală latero-laterală, izoperistaltică, de 60 mm. Durata medie a spitalizării a fost de $7 \pm 1,3$ zile, fără complicații Clavien-Dindo de grad III și IV. Nu au fost raportate abcese abdominale postoperatorii sau fistule anastomotice.

Concluzii: Abordul total laparoscopic reprezintă o procedură sigură pentru pacienții cu apendicită complicată care necesită rezecție ileo-colică.

Cuvinte cheie: chirurgie colorectală, apendicectomie, chirurgie minim invazivă, rezecție ileocecală, colectomie de urgență

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Abstract

Introduction: Acute appendicitis remains one of the most common surgical emergencies worldwide. Complicated acute appendicitis may present as perforated or gangrenous appendicitis with a compromised appendiceal base. This is a challenging scenario for surgeons that may require, in some cases, an ileocolic resection. This study aims to demonstrate the advantages and efficacy of a minimally invasive approach to complicated appendicitis requiring ileocolic resection.

Materials and Methods: We reviewed patients who underwent extended resection for complicated acute appendicitis at our hospital from January 2022 to May 2024. Baseline, preoperative, intraoperative and postoperative features were analyzed.

Results: During the study period, 15 patients with acute appendicitis required laparoscopic extended resection. Nine (56.2 %) underwent ileocecal resection, and 6 (43.8%) underwent right colectomy. All patients had an intracorporeal side to side, isoperistaltic 60 mm mechanical anastomosis. Mean length of stay was 7 ± 1.3 days with no CD III and IV complications. No postoperative abdominal abscesses or anastomotic leaks occurred.

Conclusions: Totally laparoscopic approach is a safe procedure for patients with complicated appendicitis requiring ileocolic resection.

Key words: colorectal surgery, appendectomy, minimally invasive surgery, ileocecal resection, emergency colectomy

Introduction

Laparoscopic appendectomy is one of the most common emergency surgeries worldwide. Appendicitis can present with varying severity, typically classified as uncomplicated - when inflammation is confined to the appendix - or complicated, characterized by findings such as an appendicular abscess, peritonitis, gangrene, or perforation (1).

The preoperative workup is crucial for distinguishing between complicated and uncomplicated appendicitis. Ultrasound and abdominal computerized tomography (CT) scan with intravenous contrast can detect the presence of free air, free fluid in the abdomen, or an intraperitoneal abscess. Inflammatory markers, such as white blood cell count, C-reactive protein, and procalcitonin, also correlate with the extent of the infection (2-3).

Cases involving necrosis of the appendiceal base represent a distinct clinical scenario (4). In such cases, simple removal of the appendix may be insufficient. The necrotic appendiceal base may not ensure stump stability, posing a risk for postoperative complications. Extending the resection to include the cecum may be necessary to secure a margin of healthy, viable tissue. In particularly severe or rare cases, an ileocecal resection or even a right colectomy may be required. These challenging, urgent situations necessitate the creation of an ileocolic anastomosis (5-6). Often, they result in conversion to an open

procedure, which can lead to worse postoperative outcomes for patients.

Avoiding risky laparotomies by performing a totally laparoscopic approach can be challenging but may significantly improve patient outcomes (7). The available literature on a minimally invasive approach to ileocolic resection for acute appendicitis is limited, with most procedures performed as open surgeries or requiring conversion to an open approach. Here, we report a series of 15 consecutive patients who underwent a totally laparoscopic ileocolic resection with intracorporeal anastomosis for acute appendicitis with appendiceal base necrosis.

Materials and Methods

Patients undergoing laparoscopic exploration between January 2022 and May 2024 for suspected acute appendicitis were retrospectively reviewed from a prospectively maintained institutional database.

We included patients who underwent totally laparoscopic ileocolic resection for acute appendicitis with appendiceal base necrosis. Baseline patients' characteristics (gender, age, ASA score and BMI) were registered as well as preoperative, intraoperative and postoperative variables, including temperature, white blood cell (WBC) count and C-reactive protein (CRP) on admission; days from the onset of the symptoms to hospital admission were analyzed. CT scan features such as free air, free fluid or

thickening of the cecal walls were inquired (*Fig. 1*).

Intraoperative findings were collected (*Fig. 2*). Extension of the cecum necrosis detected by Indocyanine Green (ICG) (8), type of procedure, surgical time, blood loss, conversion rate and type of anastomosis were reported.

In all cases of acute appendicitis, a 10-12 mm trocar was placed at the umbilicus, a second 10-12 mm trocar in the left flank, and a 5 mm trocar in the hypogastrium. If exploratory laparoscopy revealed necrosis of the cecal base, a fourth trocar was inserted at the epigastric level. Once it was determined that the safest procedure for the patient was an ileocecal resection, the last ileal loop and the right colon were mobilized. The ileocolic vessels were isolated and ligated distally. Both ileal and colonic transections were performed using a 60 mm endostapler. A side-to-side isoperistaltic ileocolic mechanical anastomosis was created using a 45 mm endostapler. The stapler insertion site was closed with a double-layered barbed running suture. Adequate peritoneal lavage was performed, and two drains were placed in the Douglas pouch and the right abdominal quadrant.

Postoperative parameters such as length of hospital stay, Clavien-Dindo (CD) complication rate (9), postoperative anastomotic leak, peritoneal abscesses, and postoperative ileus were collected.

Continuous variables were described as mean (standard deviation) or median (interquartile range-range) as appropriate, categorical variables as frequencies and percentage.

Results

Between January 2022 and May 2024, 675 patients



Figure 1. Acute appendicitis with fistulized abscess in the abdominal wall and cecum inflammation. (A) Coronal section. (B) Axial section.

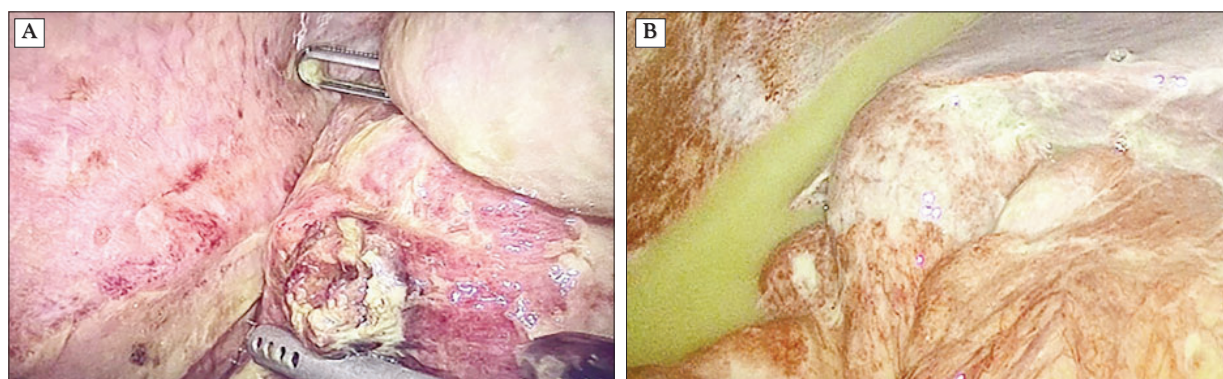


Figure 2. Intra-operative findings. (A) Perforated appendiceal base. (B) Diffuse purulent peritonitis.

underwent exploratory laparoscopy for suspected appendicitis. Intraoperative diagnosis of appendicular base necrosis was observed in 15 cases (2.2%). All patients had high WBC count and CRP on admission, mean blood lactate level was 1.9 ± 1.1 mmol/L. Median age was 48 (38-69) years, mean body mass index was 26.2 ± 2.3 kg/m². All patients had fever on admission. Mean time from the onset of symptoms to emergency room admission was 3 ± 1.2 days. All patients underwent abdominal CT scan with intra venous contrast. Free fluid was detected in all cases while free air was seen in 5/15 cases (33.3%). Patients' characteristics are reported in *Table 1*.

All patients underwent exploratory laparoscopy. Nine procedures (56.2%) were performed during the 8.00 am – 8.00 pm shift, while 6 (43.8%) happened during the night shift. A purulent peritonitis of the right abdominal quadrants was found during all procedures. Peritoneal lavage was performed in all cases. ICG test was always performed to check the extension of the appendiceal/cecum necrosis and final anastomosis perfusion (*Fig. 3*).

Nine patients (56.2%) underwent an ileocecal resection, 6 (43.8%) underwent a right colectomy for necrosis extended beyond the cecum. All patients had an intracorporeal side to side isoperistaltic 60 mm mechanical anastomosis with a double layer closure of the anastomotic breach. All procedure were performed by skilled (> 100 procedures) colorectal mini-invasive surgeons.

Mean length of stay was 7 ± 1.3 days, CD I and II complication rate was 40% (6/15). There were no CD III and IV complications. Three patients (20%) had a post-operative ileus. No postoperative abdominal abscess or anastomotic leak happened (*Table 2*). All patients received postoperative wide spectrum antibiotic therapy.

Discussion

A totally laparoscopic ileocolic resection with intracorporeal anastomosis for cecal ischemia following appendiceal base necrosis is a safe and effective emergency treatment when performed by experienced colorectal minimally invasive surgeons.

An underestimated case of appendicitis can lead to inflammation extending to the appendiceal base or the cecum, complicating surgical treatment. In adults, particularly, the incidence of appendicitis is lower than in younger populations, which can lead to diagnostic delays due to patient hesitation to seek emergency care. In our experience, patients' reluctance to seek immediate

Table 1. Baseline and preoperative patients' characteristics

Variable	Patients (N = 15)	%
Male	9	60%
Age (median)	48 (38 – 69)	
BMI	26.2 ± 2.3	
ASA I	6	40%
ASA II	6	40%
ASA III	3	20%
ASA IV	0	0%
WBC at admission	19.200 ± 3900	
CRP at admission	184 ± 38.6	
Temperature > 38°	15	100%
Days from symptoms to admission	3 ± 1.2	
Free air at CT	5/15	33%
Free fluid at CT	15/15	100%
Blood lactate at admission	1.9 ± 1.1	

BMI = Body Mass Index; WBC = white blood cell count; CRP = C – reactive protein; CT = computerized tomography.



Figure 3. Laparoscopic ileocolic anastomosis with vascularization assessment using ICG.

Table 2. Intraoperative and postoperative features.

Male	9	60%
N°	15	%
Laparoscopic surgery	15	(100%)
Right colectomy	6	(43.8%)
Ileocecal resection	9	(56.2%)
Surgery during night shift	6	(43.8%)
Conversion rate	0	(0%)
Surgical time (min)	96 ± 29	
Blood loss (ml)	35 ± 12	
Length of the specimen (cm)	25 ± 13	
ICG use	15	(100%)
Intracorporeal anastomosis	15	(100%)
Length of stay (days)	7 ± 1.3	
Anastomotic leak	0	(0%)
CD 3	0	(0%)
CD < 3	6	(40%)
p.o. Ileus	3	(20%)
p.o. Antibiotic Therapy	15	(100%)
p.o. Abscess	0	(0%)

CD = Clavien-Dindo; p.o = postoperative. ICG = indocyanine green;

medical attention, particularly among adults, may be a lingering effect of the COVID-19 pandemic. Prior to the pandemic, severe cases of appendicitis requiring ileocecal resection with anastomosis were rare. This may explain why 2% of patients who underwent laparoscopy for suspected appendicitis required a resection. At our institution, complicated appendicitis with a necrotic appendiceal base can be managed either with a partial cecal resection using a stapler or with an ileocolic resection, depending on the extent of necrosis as assessed by ICG uptake in fluorescence imaging.

A recent retrospective population-wide analysis by Uttingher et al. found worsened clinical outcomes when surgery was delayed beyond 12 hours from admission for complicated appendicitis and beyond 24 hours for uncomplicated appendicitis. Both clinical outcomes and mortality increased if appendectomy was performed during emergency hours (10).

Similarly, Li et al. retrospectively examined the impact of surgical waiting time and risk factors on postoperative complications after appendectomy, noting that surgical outcomes can be influenced by preoperative factors and time to surgery. They recommended that high-risk patients undergo appendectomy within 12 hours to reduce the likelihood of postoperative complications (11-12).

Conversely, the EAST Appendicitis Research Group retrospectively analyzed the MUSTANG database and concluded that a delay of ≥ 24 hours from ED triage to appendectomy was not associated with an increased risk of progression from simple to complicated appendicitis. Instead, the worsening of clinical features was more closely related to factors such as older age, smoking history, and prior surgeries (13).

However, a recent update of a Cochrane review, initially published in 2017, attempted to assess the effects of early versus delayed appendectomy on overall morbidity and mortality in patients with appendiceal phlegmon or abscess. Despite the large number of studies reviewed, the data were sparse, making it difficult to determine any significant benefits or harms of early versus delayed appendectomy. The conclusions indicated that early appendectomy may reduce the total length of hospital stay and increase time away from normal activities, but the evidence remains very uncertain (14).

Despite the lack of conclusive evidence, a significant diagnostic delay may still be associated with increased severity of clinical presentation. In adults, right iliac fossa pain does not always raise immediate concern as it often does in children (15).

Access to the emergency room is often delayed until the onset of fever and the persistence of symptoms prompt the adult patient to seek medical attention. The progression of appendiceal inflammation can lead to necrosis of the appendix itself, perforation, or extension of necrosis to the base of the appendix, subsequently involving the cecum.

As reported by Caballero-Alvarado, patients with gangrenous or perforated appendicitis may present with a compromised appendiceal base. Treating these patients poses a significant challenge, as a necrotic base may complicate closure. This can result in complications such as dehiscence of the closure stump, leading to fecal peritonitis or the formation of fistulae (6,16).

The possibility of performing an ICG test is a critical asset in a surgeon's armamentarium during an abdominal emergency (17). In cases of suspected cecal necrosis, ICG technology can be utilized to assess the extent of necrosis, aiding in surgical planning. An ileocecal resection or even a right colectomy may become necessary to facilitate the creation of an ileocolic anastomosis on viable tissue (6,18).

Performing an emergency colonic resection may deter surgeons from employing minimally invasive techniques. However, it is well established that in the hands of experienced practitioners, laparoscopy can reduce the rates of postoperative complications, shorten hospitalization, and decrease the incidence of postoperative paralytic ileus (19). Moreover, avoiding laparotomies in contaminated abdomens could prevent post-operative wound infections (20). Performing a laparoscopic ileocecal resection or right colectomy in the emergency setting can be challenging; however, the postoperative benefits for patients are well recognized (21).

Furthermore, performing the ileocolic anastomosis intracorporeally is undoubtedly the most challenging step of any right-sided colonic resection. However, this approach eliminates the need for a midline incision, thereby reducing the incidence of wound infections. Additionally, intracorporeal ileocolic anastomosis is associated with shorter hospital stays and a lower incidence of postoperative ileus compared to extracorporeal anastomosis during laparoscopic right-sided resections, while maintaining a similar rate of anastomotic leaks (22).

Turgut et al. reported a case series spanning 5 years involving 55 patients who underwent extended resection for complicated appendicitis, including 32 right colectomies and 23 ileocecal resections, although the type of surgical approach

was not specified. Among these patients, 8 experienced complications classified as Clavien-Dindo grade > III, 3 developed postoperative ileus, and 3 patients died (18). In contrast, all patients in our series underwent laparoscopic surgery, with no complications classified as Clavien-Dindo grade > III and no mortality observed.

Yilmaz et al. reported a retrospective series of patients undergoing laparoscopic partial cecum resection using an endostapler for acute complicated appendicitis with appendiceal base necrosis over a 5-year period. While this technique avoids the need for anastomosis, cases of peritoneal abscesses were reported. The primary challenge associated with this approach is managing the necrotic appendiceal base near the ileocecal valve, as the endo-stapler line may lead to bowel obstruction (23).

To the best of our knowledge, this is the first series of patients undergoing a totally laparoscopic procedure in an emergency setting for complicated appendicitis with appendiceal base necrosis.

The limitations of our study include its retrospective nature, single-center design, the small number of patients, and the fact that all operations were performed by experienced surgeons, which may introduce bias into the results. The lack of a control group is a reason to interpret the results with extreme caution, although very limited literature is available on the topic, and our study represents one of the major case series available. For the mentioned reasons, the study does not imply reproducibility or external validity, offering a low level of evidence in a setting where very limited data exists in the literature.

Conclusion

In conclusion, a totally minimally invasive approach to ileocolic resection for acute appendicitis is feasible when performed by expert colorectal surgeons. However, further evidence is needed on this topic, given the current lack of comprehensive data.

Authors' Contributions

Conceptualization and study design: GMM, JC, DM Data collection: FR, RS, EDF, BV, MG, MS Data analysis and statistical analysis: FR, AM, MG, GMM Methodology support: RS, CM, MS Data interpretation: AM, AG Literature review: EDF, BV Manuscript drafting: GMM, JC, FR Manuscript revision: RS, EDF, AM, CM, AG, BV,

MG, MS Study supervision and final approval: DM, CM, AG

Conflicts of Interests

The authors declare no conflict of interest.

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Ethical Statement

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Consent was waived due to the retrospective nature of the study. However, all patients treated at our institution provide a general consent for research purposes. The confidentiality and anonymity of participants were maintained throughout the study. No identifiable patient information is disclosed in this publication.

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