

Utilization and outcomes of Hartmann's procedure in emergency left colon surgery: evaluating postoperative complications and stoma reversal rates

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ABSTRACT. – OBJECTIVE: The aim of the study was to investigate the utilization and outcomes of Hartmann's procedure in the emergency left colon surgery with respect to other stoma interventions.

PATIENTS AND METHODS: A total of 70 consecutive patients (mean±SD age: 71.1±15.5 years, 51.4% were males) who underwent emergency surgery for the left colon were included in this retrospective cohort study. Data on patient demographics, primary diagnosis, emergency surgery indication, operative risk, stoma type (Hartmann's procedure, primary anastomosis with diverting loop ileostomy, double-barreled ostomy), surgeon sub-specialty, postoperative complications, and stoma reversal time and rates were recorded.

RESULTS: Hartmann's procedure (72.9%) was the most commonly utilized stoma type, followed by primary anastomosis with diverting loop ileostomy (14.3%) and double-barreled ostomy (10.0%), while primary anastomosis was performed only in 2.8% of patients. The stoma reversal rate was 25.0%, and the median time to stoma reversal was 10 months (range, 3 to 48 months). Hartmann's procedure was less commonly performed by colorectal surgeons than by general surgeons (35.3% vs. 68.4%, $p=0.013$) and was associated with a lower chance of stoma reversal compared to other stoma types, including primary anastomosis with diverting loop ileostomy and double-barreled ostomy (15.7% vs. 52.9%, $p=0.006$).

CONCLUSIONS: In conclusion, our findings revealed that Hartmann's procedure, although performed less commonly by colorectal surgeons than by general surgeons, was still the most prevalent procedure applied for the surgical management of left colon emergencies, particularly in the setting of tumor-induced obstruction or perforation, despite the potential risk of severe postoperative complications and lower stoma reversal rates with this procedure.

Key Words:

Left colon emergency surgery, Sigmoid colon resection, Hartmann's procedure, Primary anastomosis, Stoma reversal.

Introduction

Hartmann's procedure, known as a rectosigmoid resection with end colostomy and distal stump, is indicated for a range of left colon pathologies, especially in the emergency setting (e.g., malignancy, diverticulitis, ischemia, volvulus, or trauma) and in the presence of perioperative conditions jeopardizing a safe colorectal anastomosis^{1,2}.

As an operation faster and easier than resection/anastomosis with the added benefit of no risk of anastomotic leakage, Hartmann's procedure has become the favored option for emergent left colon surgery, particularly for the less experienced and non-specialist surgeons²⁻⁵.

However, the need for a second major operation for restoration of intestinal continuity, which has its own morbidity and mortality, is considered the main disadvantage of Hartmann's procedure^{1,4}. Besides, the stoma reversal can be achieved in less than 50% of patients in clinical practice, significantly affecting their quality of life^{1,3,4}. Recent studies⁶⁻⁹ also indicated that sigmoidectomy with primary anastomosis with or without diverting ileostomy is equal to or even better than Hartmann's procedure in terms of postoperative mortality and morbidity.

Nonetheless, Hartmann's procedure still has a wide utilization range in emergency left colon surgery practice as it can be performed by any surgeon, despite being associated with a low rate

of restoration of continuity and high morbidity and mortality^{1,3}. The ideal surgical approach in left colon emergencies, as well as the ideal time interval for restoration of continuity in Hartmann's procedure, remain controversial, while several factors besides the surgical procedure itself determine the postoperative outcome, such as the surgeon's experience and specialization, the general condition and comorbidity burden of the patient, the primary diagnosis and the timing of stoma reversal^{1,3,10}.

Therefore, this study aimed to investigate the utilization and outcomes of Hartmann's procedure in emergency left colon surgery with respect to other stoma interventions (primary anastomosis with diverting loop ileostomy, and double-barreled ostomy) *via* a comparative analysis of patient characteristics, primary diagnosis, operative risk, surgeon's subspecialty, postoperative morbidity, and stoma reversal rates.

Patients and Methods

Study Population

A total of 70 consecutive patients (mean±SD age: 71.1±15.5 years, 51.4% were males) who underwent emergency surgery for the left colon at a tertiary care hospital between January 2018 and January 2023 were included in this retrospective cohort study. Patients (aged >18 years) with emergency surgery indications (obstruction, perforation, or bleeding) due to sigmoid colon pathologies were included in the study, while those who underwent emergency surgery for primary rectal or non-sigmoid colon pathologies were excluded.

This study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki and approved by the Bursa Uludag University Clinical Research Ethics Committee (date of approval: 18/12/2023; protocol No.: 2011-KAEK-26/908).

Assessments

Data on patient demographics (age, gender), primary diagnosis, emergency surgery indication, operative risk *via* the American Society of Anesthesiologists (ASA) score (low operative risk: ASA score I-II, high operative risk: ASA score III-V), stoma type (Hartmann's procedure, primary anastomosis with diverting loop ileostomy, double-barreled ostomy) applied after the sigmoid colon resection, the surgeon sub-specialty, severity of postoperative complications *via* Clavien Dindo

Classification (mild: grade I-II, severe: grade III to V), length of hospital stay (LOS, day), stoma reversal rates with reasons for failure and time to stoma reversal (months) were recorded in each patient and compared across stoma types (Hartmann's procedure *vs.* other techniques).

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). Chi-square (χ^2) test and Fischer's exact test were used for the comparison of categorical data. Mann-Whitney U test and independent sample *t*-test were used for the parametric variables. Data were expressed as mean ± standard deviation (SD), median (minimum-maximum), and percent (%) where appropriate. $p < 0.05$ was considered statistically significant.

Results

Baseline Characteristics

The mean±SD patient age was 71.1±15.5 years, and males comprised 51.4% of the overall study population. Tumor (47.1%) was the leading primary diagnosis, followed by diverticulitis (17.1%), ischemic colitis (12.9%), and volvulus (10.0%). Perforation (50.0%) and obstruction (48.6%) were the main emergency surgery indications. High operative risk (ASA score III-IV) was evident in 41.4% of patients (Table I).

Surgery Types, Surgeon Sub-Specialty, Postoperative Outcome and Stoma Reversal Rates

Hartmann's procedure (72.9%) was the most commonly utilized stoma type, followed by primary anastomosis with diverting loop ileostomy (14.3%) and double-barreled ostomy (10.0%), while primary anastomosis was performed only in 2.8% of patients (Table II).

Overall, general surgeons and colorectal surgeons performed 55.7% and 44.3% of operations, respectively. Clavien Dindo classification revealed grade III-V (severe) postoperative complications in 45.7% of patients (Table II).

Median LOS was 10 days (range, 7 to 15 days), while the median time to stoma reversal was 10 months (range, 3 to 48 months) (Table II).

Stoma reversal was performed in 17 (25.0%) patients but could not be performed in 49 (72.1%) patients due to patient factors (poor general condition or lack of consent), technical factors

Table I. Baseline characteristics.

Patient demographics	
Age (year), mean±SD	71.1±15.5
Gender, n (%)	
Female	34 (48.6)
Male	36 (51.4)
Primary diagnosis, n (%)	
Tumor	33 (47.1)
Diverticulitis	12 (17.1)
Ischemic colitis	9 (12.9)
Volvulus	7 (10.0)
Other	9 (12.9)
Emergency surgery indication, n (%)	
Obstruction	34 (48.6)
Perforation	35 (50.0)
Bleeding	1 (1.4)
ASA score	
I-II (low operative risk)	41 (58.6)
III-V (high operative risk)	29 (41.4)

ASA: American Society of Anesthesiologists.

(unresectable local recurrence, progression, stenosis and short rectal stump precluding closure operation) and mortality after hospital discharge in 18 (36.7%), 17 (34.7%) and 14 (28.6%) patients, respectively (Table II).

Study Parameters by the Stoma Type (Hartmann's Procedure vs. Other Techniques)

No significant difference was noted between Hartmann's procedure and the other techniques in terms of patient demographics, operative risk status (ASA scores), emergency surgery indications, postoperative complication severity (Clavien Dindo grade), and LOS (Table III, Figure 1).

Hartmann's procedure was less commonly performed by colorectal surgeons than by general surgeons (35.3% vs. 68.4%, $p=0.013$) and was associated with lower chance of stoma reversal compared to other stoma types including primary anastomosis with diverting loop ileostomy and double-barreled ostomy (15.7% vs. 52.9%, $p=0.006$) (Table III, Figure 1).

Table II. Surgery types, surgeon sub-specialty, postoperative outcome, and stoma reversal rates.

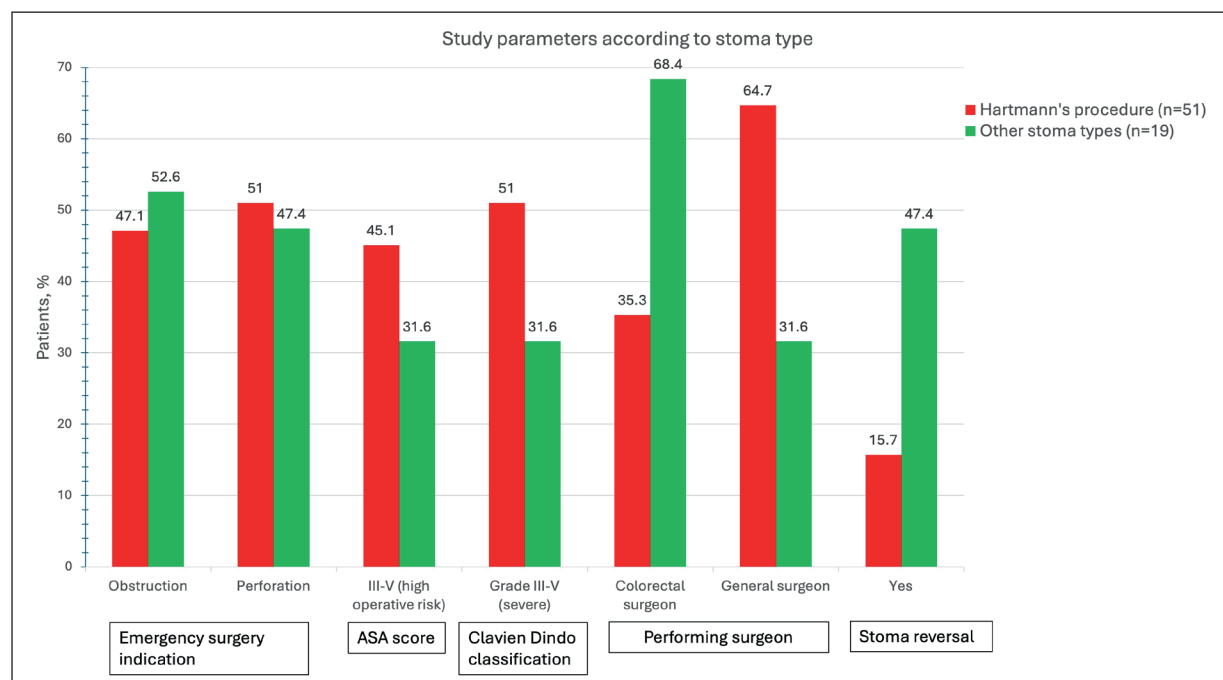
Stoma type after sigmoid colon resection, n (%)	
End colostomy (Hartmann's procedure)	51 (72.9)
Primary anastomosis + diverting loop ileostomy	10 (14.3)
Double-barreled ostomy	7 (10.0)
Primary anastomosis	2 (2.8)
Surgeon sub-specialty, n (%)	
Colorectal surgeon	31 (44.3)
General surgeon	39 (55.7)
Clavien Dindo classification, n (%)	
Grade I-II (mild)	38 (54.3)
Grade III-V (severe)	32 (45.7)
Length of hospital stay (day), median (min-max)	
Stoma reversal (n=68) ^a , n (%)	10 (7-15)
Yes	17 (25.0)
No	49 (72.1)
Missing data	2
Reasons for lack of stoma reversal (n=49), n (%)	
Patient factors (poor general condition or lack of consent)	18 (36.7)
Technical factors (unresectable local recurrence, progression, stenosis, short stump)	17 (34.7)
Mortality after hospital discharge	14 (28.6)
Time to stoma reversal (month), median (min-max)	
	10.0 (3-48.0)

^aExcluding two patients with primary anastomosis (n=68).

Table III. Study parameters by the stoma type (Hartmann's procedure vs. other techniques).

	Stoma type after sigmoid colon resection		p-value
	Hartmann's procedure (n=51)	Other techniques (n=19)	
Patient demographics			
Age (year), mean±SD	72.6±15.0	66.9±16.4	0.120
Gender (male), n (%)	26 (51.0)	10 (52.6)	0.900
ASA score			
I-II (low operative risk)	28 (54.9)	13 (68.4)	0.310
III-V (high operative risk)	23 (45.1)	6 (31.6)	
Emergency surgery indication			
Obstruction	24 (47.1)	10 (52.6)	0.78
Perforation	26 (51.0)	9 (47.4)	
Bleeding	1 (2.0)	0 (0.0)	
Surgeon specialty, n (%)			
Colorectal surgeon	18 (35.3)	13 (68.4)	0.013
General surgeon	33 (64.7)	6 (31.6)	
Clavien Dindo classification, n (%)			
Grade I-II (mild)	25 (49.0)	13 (68.4)	0.140
Grade III-V (severe)	26 (51.0)	6 (31.6)	
LOS (day), median (min-max)	10 (7-15)	8 (6-27)	0.810
Stoma reversal, n (%)	8 (15.7)	9 (52.9) ^a	0.006

ASA: American Society of Anesthesiologists; LOS: Length of hospital stay. ^aExcluding two patients with primary anastomosis (n=17).

**Figure 1.** Study parameters according to stoma type (Hartmann's procedure vs. other techniques).

Although not significant, patients who underwent Hartmann's procedure were more likely to have high operative risk (ASA scores III-V, 45.1% vs. 31.6%, $p=0.310$) and severe postoperative complications (Clavien Dindo grade III-V, 51.0% vs. 31.6%, $p=0.140$) than those operated with other stoma techniques (Table III, Figure 1).

Discussion

In this retrospective cohort of patients with left colon emergencies, tumor-induced perforation or obstruction was the leading indication for surgery, and Hartmann's procedure (formation of an end colostomy) was the most commonly preferred post-resection stoma technique, despite its association with a lesser likelihood of stoma reversal than other stoma types (i.e., primary anastomosis with diverting loop ileostomy and double-barreled ostomy). Overall, most operations were performed by general surgeons, but Hartmann's procedure was less commonly performed by colorectal surgeons.

The primary diagnoses (tumor, diverticulitis, ischemic colitis, and volvulus) in our cohort are consistent with the main indications for Hartmann's procedure^{1,2,10}, while its utilization rate (~73%) also supports that Hartmann's procedure remains the favored option for most surgeons, enabling a shortened operation time and a reduced risk of surgical trauma, particularly in high-risk patients^{1,2,4,5,10}. However, the stoma reversal rates (~16%) after Hartmann's procedure in our cohort also correlate with previous studies^{1,3,4,10-12} emphasizing a low rate of stoma closure in patients receiving this procedure. Hence, while the creation of a stoma as part of Hartmann's procedure is often considered temporary and technically reversible with a second operation by the surgeons, large numbers of patients are left with a permanent stoma following this procedure^{2,10,12}.

Overall, the stoma reversal rate after a Hartmann's procedure is considered to range from 19% to 71% for all etiologies combined, while stoma reversal rates of as low as 24-40% have been reported particularly in the setting of colorectal cancer^{1,2,10,12,13}. Although benign indications for left colon emergency surgery were more commonly reported in the multicenter studies with large series², nearly half of our patients were oncology patients, possibly related to the fact that our hospital is a tertiary care

referral center. Hence, besides the other factors, the oncological condition itself seemed to be the primary determining factor for both the decision to perform a stoma closure and the timing of the procedure in these patients^{10,14,15}. Notably, in a colostomy series in left-sided colorectal cancer, stomas were closed in only 26.6% of patients who underwent Hartmann's procedure in a period of 6-12 months, and a decreasing rate of stoma closure (increased likelihood of permanent colostomies) was reported with advancing tumor stage (Stage II: 36%, Stage III: 21.1% and Stage IV: 5.3%)¹⁰. In a study¹⁵ with 118 patients who underwent Hartmann's emergency procedure, the most common indications for Hartmann's procedure were diverticular complications (60%) and benign perforated sigmoid or rectosigmoid cancer (16%), while the average timeframe for reversal was within 18-20 months and the reversal rate was 34.9%. The highest reversal rate was observed in younger and fitter (I-II) ASA-grade patients, and there was a higher rate of reversal in benign conditions than in malignant conditions¹⁵.

Stoma reversal could not be performed in 49 (72.1%) patients in our cohort, while the patient factors (poor general condition or lack of consent), technical factors (unresectable local recurrence, progression, stenosis or short rectal stump precluding closure operation) and mortality after hospital discharge comprised the main reasons for not performing stoma reversal in 36.7%, 34.7%, and 28.6% of these patients, respectively. In a study² with 228 patients (ASA III-V: 40%) who underwent Hartmann's procedure for indications of complicated diverticular disease (44%), malignancy (32%), and other causes (24%), the stoma reversal rate was 47% and median time to reversal of Hartmann's was 11 months (range 4-96 months). The main reasons for failure to perform reversal were reported as recurrent malignancy (35%), high-risk comorbidity (55%), or anticipated technical difficulties (i.e., dense pelvic adhesions or a short rectal stump; 10%), while 30 patients declined reversal either due to satisfaction with current stoma or not wanting further surgery².

Likewise, other studies^{1,2,10,12,13,16} also revealed an elevated ASA score \geq III, age $>$ 75 years, the presence of an advanced-stage tumor, metastatic cancer, patient refusal, and the technical impossibility of accessing the rectal stump (dense pelvic adhesions, chronic pelvic infection, a short rectal stump) as the main factors underlying a decision of not restoring the continuity.

Nonetheless, it should be noted that Hartmann's procedure is often performed for high-risk patients with older age, poor nutritional status, comorbid diseases, higher ASA scores, unstable hemodynamic status, or obesity, and this is considered likely to explain the high morbidity and mortality rates as well as low stoma reversal rates in patients receiving this procedure^{1,10,16,17}. Similarly, in our cohort, Hartmann's procedure appeared to be more commonly performed in patients with a high operative risk (ASA score III-V) and to be more commonly associated with severe postoperative complications (Clavien Dindo grade III-V) when compared to other stoma types, supporting that severe postoperative complications occur in 27% of cases (range, 5.4% to 54.8%) after this procedure^{2,18,19}.

The ideal timeframe for stoma reversal remains a major dilemma since extending the deadline improves the healing of tissues and ameliorates underlying inflammation but also causes the atrophy of the rectal stump, challenging its localization and dissection during the second intervention^{1,20}. While the restoration of continuity after Hartmann's procedure is often performed at a median of 7.6 months (range, 5.6 to 13.3 months)^{1,2,13,15}, this period is considered to be more heterogeneous and even longer in the case of malignant *vs.* benign initial conditions (9.2 months *vs.* 12.6 months) due to need for postoperative adjuvant systemic chemotherapy in cancer patients, considerably delaying the second-stage restorative surgery^{1,3}. The median time to stoma reversal was 10 months (range, 3 to 48 months) in our patients, which seems consistent with the tumor-induced indications for emergent left colon surgery in nearly half of the patients in our cohort. Therefore, lower rates for anastomotic leakage, postoperative complication, and mortality have been reported in patients whose stomas were closed 6-9 months after the first operation *vs.* those with earlier stoma closure^{10,21}. However, according to the National Bowel Cancer Audit²², in 2015, 95% of patients undergoing Hartmann's still have a stoma at 18 months increasing the likelihood of their stoma to become permanent^{2,23}.

Recent studies⁶⁻⁹ have reported no significant advantage of Hartmann's procedure to sigmoidectomy with primary anastomosis (as a one-stage procedure not requiring stoma) in terms of postoperative mortality and morbidity. Moreover, other stoma techniques (i.e., primary anastomosis with diverting loop ileostomy) were

also found to be superior to Hartmann's procedure in patients with perforated diverticulitis in terms of several factors with important implications for health-care costs and patients' quality of life, such as better long-term stoma-free survival, higher stoma reversal rates (85-92% *vs.* 50-60%), shorter median time to stoma reversal and reduced morbidity after stoma reversal with fewer serious complications (Dindo-Clavien IIIb or IV) and a higher recovery rate^{6-9,24,25}. Primary anastomosis following colonic resection is also suggested to be safely performed in the setting of obstructive left colon cancer with the necessary surgical expertise, resulting in no increased risk of mortality, anastomotic leakage, or other postoperative complications²⁶. For patients with ischemic colitis or sigmoid volvulus in the emergency setting, the utility of Hartmann's procedure remains an alternative for management with careful consideration of its impact on the patient's general condition, but limited data exist on stoma reversal rates^{1,27}.

The ideal treatment approach in left colon emergencies is still controversial and closely related to the surgeon's experience as well as the general condition of the patient^{10,28}. In our cohort, 73% of patients received a Hartmann's procedure, 14.3% received primary anastomosis with diverting loop ileostomy, 10.0% received double-barreled ostomy, and only 2.8% received primary anastomosis. Colorectal surgeons performed 44.3% of overall operations but only 35.3% of Hartmann's procedures and almost 69% of other techniques, emphasizing a considerable difference among surgeons in the day-to-day practice for the adopted for colonic resections depending on the specialization of the surgeon^{2,3,29}. Despite its potential drawbacks (i.e., increased risk of postoperative complications, lower stoma reversal rate), Hartmann's procedure remained a favored option for left colon emergency surgery by the general surgeons in our study. Accordingly, our findings support that some surgeons without subspecialties in general surgery (not performing primary anastomosis on a regular basis) may prefer Hartmann's procedure over primary anastomosis since it is a more straightforward procedure with shorter operative time, increasing its selection as a safe and viable option, particularly for high-risk comorbid patients^{2,29,30}. Likewise, in a series of 336 emergency colorectal procedures performed in the UK for cancer and diverticular disease, a primary anastomosis was reported to be more

commonly performed by colorectal surgeons than by non-colorectal surgeons (64.3% vs. 36.5%), and for both operations, the overall morbidity and mortality rates were lower for colorectal surgeons (14.5% vs. 24.3% and 10.4% vs. 17.4%, respectively)²⁹. Also, in a study³⁰ from the USA, colorectal surgeons were reported to be more likely to perform primary anastomosis than general surgeons and to achieve shorter operating times and length of stay and equivalent morbidity and mortality to their general surgical colleagues.

Notably, in a series of 10,780 emergency colectomy operations performed in the USA for diverticulitis, 98.3% of patients received a Hartmann's procedure, and 1.7% received primary anastomosis with proximal diversion, while colorectal surgeons performed 6.0% of all operations, indicating that the majority of urgent/emergent colectomies for diverticulitis are not performed by colorectal surgeons⁵. Colorectal surgeons vs. non-colorectal surgeons were found to less commonly utilize primary anastomosis with proximal diversion (1.5% vs. 4.2%), while postoperative mortality was 2-fold greater when non-colorectal surgeons performed primary anastomosis vs. Hartmann procedure (15% vs. 7.4%) and 1.4 times greater among non-colorectal surgeons than among colorectal surgeons (7.5% vs. 5.3%)⁵. On the multivariable logistic regression analysis, the colorectal board certification was found amongst the independent determinants of decreased mortality, while the primary anastomosis with proximal diversion, despite being a guideline-recommended option for perforated diverticulitis, was found to be associated with increased risk of postoperative morbidity and mortality when performed by general surgeons⁵. Hence, a move towards centralization of services with 24-hour-a-day access to colorectal surgeons is suggested to reduce the number of Hartmann's procedures performed overall and to increase the utilization of primary anastomosis with or without diverting ileostomy in emergent colectomies^{2,5,15,30}.

Limitations and Strengths

The relatively low sample size due to the retrospective single-center design seems to be a major limitation of our study in terms of potential bias in disease severity based on patient selection as well as the reliability of subgroup analysis regarding different stoma types. Nevertheless, despite these specific limitations, providing

long-term data on stoma reversal rates after emergency sigmoid colon resections performed at a tertiary care referral center, our findings make a valuable contribution to the existing but limited literature on the adopted surgical options and related outcomes in the left colon emergencies in clinical practice.

Conclusions

In conclusion, our findings revealed that Hartmann's procedure, although performed less commonly by colorectal surgeons than by general surgeons, was still the most prevalent procedure applied for the surgical management of left colon emergencies, particularly in the setting of tumor-induced obstruction or perforation. This is significant considering the higher risk of severe postoperative complications and the lower stoma reversal rates associated with this procedure, in comparison to primary anastomosis with diverting loop ileostomy and double-barreled ostomy techniques. Hence, greater participation of colorectal surgeons in urgent/emergent colectomies may decrease the number of Hartmann's procedures performed for left colon emergencies by improving the utilization of primary anastomosis with or without diverting ileostomy as a guideline-recommended strategy with favorable outcomes in terms of overall hospitalizations, long-term morbidity and quality of life.

Conflict of Interest

The authors declare that they have no conflict of interest.

Availability of Data and Materials

The data supporting this study's findings are available within the article; further inquiries can be directed to the corresponding author.

Ethics Approval

This study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki and approved by the Bursa Uludag University Clinical Research Ethics Committee (date of approval: 18/12/2023; protocol No.: 2011-KAEK-26/908).

Informed Consent

Patients gave consent for their data to be used in research.

Authors' Contributions

Conceptualization: Ercument Gurluler, Tuncay Yilmazlar; methodology: Ercument Gurluler, Tuncay Yilmazlar; data curation and formal analysis: Ercument Gurluler, Ahmet Ali Aktas, Ozgen Isik, Tuncay Yilmazlar; investigation: Ercument Gurluler, Ahmet Ali Aktas, Ozgen Isik, Tuncay Yilmazlar; project administration: Ercument Gurluler, Ahmet Ali Aktas, Ozgen Isik, Tuncay Yilmazlar; writing - original draft preparation: Ercument Gurluler; writing-review and editing: Ercument Gurluler, Tuncay Yilmazlar; supervision: Tuncay Yilmazlar. All authors have read and approved the submitted manuscript.

Funding

No funding was received for this study.

AI Disclosure

The authors declare that they have not used any type of generative artificial intelligence to write this manuscript or to create images, graphics, tables, or their corresponding captions.

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