

Optimal Timing of Colostomy and Enterostomy Reversal: Insights from A 15-Year Retrospective Analysis

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ABSTRACT

Objective: This study aimed to evaluate the impact of optimal timing of enterostomy (particularly ileostomy) and colostomy closures on postoperative complications. The goal was to compare early versus late closures to inform surgical strategies and improve patient outcomes.

Materials and Methods: Data from 474 patients who underwent ostomy closure between 2008 and 2023 were retrospectively analyzed. Based on prior literature, enterostomy patients were grouped as early (<12 weeks) or late (>12 weeks), and colostomy patients as early (<12 weeks), intermediate (13–20 weeks), or late (>20 weeks). Only patients with complete clinical records were included.

Results: Among 366 patients with enterostomy closure, 27.5% (n=101) underwent closure within 12 weeks, while 72.4% (n=265) had closure after 12 weeks. Overall complication rate was 8.4%, with serosal injury (58.1%) and perforation (38.7%) being the most frequent. Late closure was significantly associated with malignant indications (OR = 7.208), preoperative rectoscopy (OR=2.063), and adjuvant therapy (OR=1.735). In 108 patients with colostomy closure, the complication rate was 23.2%, with serosal damage (52.0%) and perforation (40.0%) being most common. Malignancy was less common in patients closed within 12 weeks, but significantly higher in the >20-week group (p<0.001). Malignancy increased the risk of delayed closure by 4.9 times according to logistic regression.

Conclusion: Optimal timing of ostomy closure is critical, especially in malignancy-related cases. Delayed closure is linked to increased complication rates. When early closure is applied to selected low-risk patients, outcomes may improve. Surgical timing should be guided by comorbidities, underlying disease, and oncologic treatment history.

Keywords: Colostomy, enterostomy, postoperative complications

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INTRODUCTION

A stoma is a surgically created opening that allows intestinal contents to exit through the abdominal wall when the continuity of the gastrointestinal tract is disrupted. The term, derived from the Greek word for “opening,” was first used in the 18th century to address intestinal obstruction in emergency settings.^[1] Today, colostomy and ileostomy are widely used in the management of various clinical conditions such as trauma, inflammatory bowel disease, and malignancy.^[2] Indications for stoma formation include bowel obstruction, perforation, diverticulitis, and protection of low anastomoses after rectal cancer surgery.^[3] In these contexts, a stoma may

be created temporarily or permanently to enhance patient outcomes and reduce the risk of complications.^[4]

The goal of stoma closure is to reestablish intestinal continuity. However, this procedure carries the risk of several complications, including anastomotic leakage, wound infection, bowel obstruction, and intra-abdominal adhesions.^[5] The likelihood of such complications is influenced by factors like surgical expertise, the patient's general condition, and the suitability of the chosen technique.^[6]

Prior studies have investigated the effects of early versus late stoma closure, reporting mixed results. Early closure has been associated with shorter hospital stays and fast-



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er wound healing,^[7] and some evidence suggests a lower rate of wound infections, although the risk of postoperative bowel obstruction may be increased.^[8] On the other hand, late closure allows inflammation to subside and provides a safer surgical field but prolongs the psychosocial burden of living with a stoma.^[9] Moreover, while late closure may be technically safer, it delays definitive restoration of function.^[10] This study aimed to evaluate the impact of closure timing on outcomes and complications through a retrospective analysis, with the goal of providing evidence-based guidance for optimal surgical planning.

MATERIALS and METHODS

Ethical Approval and Study Design

The study was conducted in accordance with the principles of the Helsinki Declaration. Approval from the Umraniye Training and Research Hospital ethics committee was obtained prior to the study (Date: 17/10/2024, Decision No: 364). The study evaluated patients between January 2008 and June 2023.

Patients aged 18 years and older who had undergone complete postoperative follow-up were included. Patients under 18 or those whose postoperative data could not be obtained were excluded. The study was conducted at a single centre.

Study Population and Grouping

A total of 474 patients were included in the study, of whom 366 underwent enterostomy (jejunostomy or ileostomy) closure and 108 underwent colostomy closure. In line with classifications used in similar studies in the literature, enterostomy patients were divided into two groups based on the timing of stoma reversal: those who underwent closure within 12 weeks postoperatively were categorized as the early group, while those who underwent closure after 12 weeks were categorized as the late group.

For colostomy cases, again based on existing literature, three subgroups were defined: early, intermediate, and late. Patients whose colostomies were closed within 12 weeks after formation were defined as the early group; those closed between 13 and 20 weeks as the intermediate group; and those closed after 20 weeks as the late group. All patients were followed for a period of one year after ostomy closure. Mortality was defined as any death occurring within 30 days following the closure procedure (Fig. 1).

Data Collection and Variables

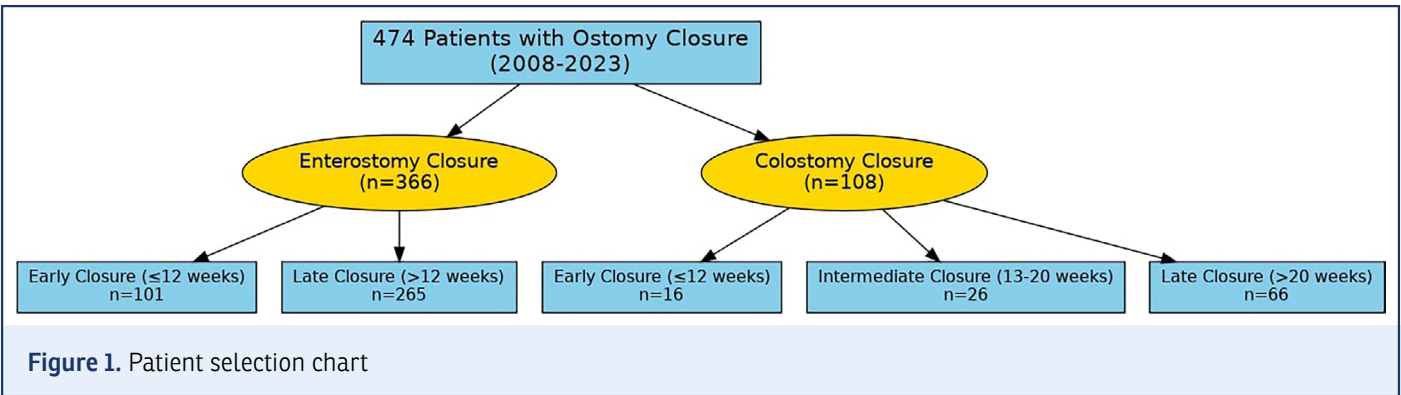
Patients with enterostomy and colostomy were compared using various demographic and clinical parameters, including age, sex, duration of hospitalization, length of ICU stay, timing of stoma closure, and total duration of stoma presence. Additional variables included the underlying indication for stoma creation (benign vs. malignant), stoma type (anatomical and functional), preoperative endoscopy findings, use of neoadjuvant or adjuvant therapies, and surgical details such as hand-sewn or stapled anastomosis, and the use of supporting sutures during closure.

Postoperative complications were classified according to the Clavien–Dindo system. These included anastomotic leakage, wound infection, intestinal obstruction, and other relevant events. Mortality and morbidity rates were also recorded and analysed.

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics version 21.0 software (IBM Corporation, Armonk, NY, USA) and Microsoft Excel 2007. A p-value of <0.05 was considered statistically significant.

The distribution of continuous variables was assessed using graphical methods and the Shapiro–Wilk test. Descriptive statistics were presented as mean ± standard deviation or median (minimum–maximum), as appropriate.



Comparative analysis of continuous variables—including patient age, postoperative hospital stay, and postoperative third-level intensive care unit (ICU) stay—was performed using the Mann–Whitney U test. In patients who underwent enterostomy (jejunostomy or ileostomy) closure, the anastomosis level (cm) was analysed in relation to anal access in the prior surgery and the timing of stoma closure.

In the colostomy group, age, postoperative hospital stay, ICU stay, anastomosis level according to anal access, and stoma closure timing were compared using the Kruskal–Wallis test.

Categorical variables were compared based on stoma closure timing using cross tabulations, frequencies (n), percentages (%), and the chi-square (χ^2) test. Potential risk factors for delayed closure were analysed using both univariate and multivariate logistic regression models. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs).

RESULTS

A total of 366 patients underwent enterostomy (jejunostomy or ileostomy) closure; 65.3% (n=239) were male and 34.7% (n=127) were female. The mean age was 58.0±14.6 years, and the median postoperative hospital stay was 9.0 (range: 2–64) days. Forty patients (11.0%) required admission to a third-level intensive care unit (ICU), with a mean ICU stay of 2.7±2.0 days. Closure occurred within 12 weeks in 27.5% (n=101) and after 12 weeks in 72.4% (n=265).

Indications for ostomy formation were benign in 21.0% (n=77) and malignant in 79.0% (n=289); benign causes included diverticular disease (1.3%), inflammatory bowel disease (39.0%), perforation (36.3%), mesenteric ischaemia (11.7%), and other (11.7%), while malignant cases comprised colon (17.3%), rectal (79.2%), and other organ malignancies (3.5%).

Ostomy configurations were loop (85.6%), tip (10.3%), and double-barrel (4.1%). Anastomosis types were ileoileal (87.4%), ileocolic (8.7%), colorectal (0.5%), ileorectal (1.4%), jejunocolic (0.5%), and jejunojejunal (1.4%); configurations were side-to-side (86.9%), end-to-side (9.8%), and end-to-end (3.3%).

Stapled anastomosis was used in 92.7% (n=339) (linear 96.2%, circular 3.8%), while 7.3% (n=27) underwent hand-sewn closure; support sutures were applied in 70.5% (n=258).

Intraoperative complications occurred in 8.4% (n=31), comprising serosal injury (58.1%), perforation (38.7%), and stenosis (3.2%), and ostomy reestablishment was required in 2.7% (n=10).

Preoperative rectoscopy findings (performed in 26.7% of cases) included polypoid lesions (32.4%), strictures (23.2%),

diversion colitis (10.1%), fistulas (8.1%), nonspecific colitis (7.1%), and other (19.1%), with a mean anastomosis level of 7.4±6.0 cm.

Neoadjuvant therapy was given to 16.7% (n=61) and adjuvant therapy to 32.0% (n=117). The postoperative 30-day mortality rate was 3.0% (n=11) and morbidity rate 15.0% (n=55); according to Clavien–Dindo classification, 49.0% were Grade I, 18.1% Grade II, 1.9% Grade III, 1.9% Grade IV, with further subgrades of 3a (n=1), 3b (n=6), 4b (n=2), and 5 (n=8) (Appendix 1).

The mean age of patients with ostomy closure ≤12 weeks was 60.3±15.9 years, while it was 57.2±14.1 years in those with closure >12 weeks. ICU admission occurred in 17.8% (n=18) of the early group and in 8.3% (n=22) of the late group. A statistically significant difference was found between groups in terms of postoperative third-level ICU admission ($\chi^2=6.808$, $p=0.009$).

Among patients with a malignant cause, 17.1% (n=13) had colon cancer, 73.7% (n=56) rectal cancer, and 9.2% (n=7) other malignancies in the early group, compared to 17.4% (n=37), 81.2% (n=173), and 1.4% (n=3), respectively, in the late group.

Intraoperative complications in the early group included serosal injury (25.0%, n=2) and perforation (75.0%, n=6). In the late group, serosal injury occurred in 69.6% (n=16), perforation in 26.1% (n=6), and stenosis in 4.3% (n=1).

Preoperative rectoscopy was performed in 16.8% (n=17) of patients with closure ≤12 weeks and in 30.6% (n=81) of those with closure >12 weeks. This difference was statistically significant ($\chi^2=8.256$, $p=0.016$). Adjuvant therapy was administered to 23.8% (n=24) in the early group and 35.1% (n=93) in the late group ($\chi^2=4.318$, $p=0.038$). No other variables showed statistically significant differences ($p>0.05$) (Appendix 2).

Univariate logistic regression showed that patients with ICU admission had a 58.3% lower risk of late closure. The risk of late closure was 6.641 times higher in patients with colon malignancy and 7.208 times higher in those with rectal malignancy, compared to other malignancies. Serosal injury during ostomy closure increased the risk of late closure 8.000-fold compared to perforation. Pathological findings on preoperative rectoscopy increased the likelihood of late closure 2.063-fold, while adjuvant therapy was associated with a 1.735-fold increased risk (Table 1).

In the enterostomy group, multivariate logistic regression did not reveal any statistically significant independent predictors of delayed closure. Although malignancy, preoperative rectoscopy, and adjuvant therapy were significant in univariate analysis, these associations were no longer present after adjusting for potential confounders. This may be attributed

Table 1. Potential risk factors associated with late closure (>12 weeks) in univariate logistic regression model

Variables	β	SD	Wald	p	OR	95% CI for OR	
						Bottom	Top
Age	-0.015	0.008	3.188	0.074	0.985	0.969	1.001
Postop 3 rd step ICU hospitalization (available)	-0.874	0.342	6.512	0.011	0.417	0.213	0.817
Malignancy type			7.807	0.020			
Colon	1.893	0.762	6.179	0.013	6.641	1.492	29.551
Rectum	1.975	0.707	7.806	0.005	7.208	1.803	28.815
Type of complication during ostomy closure (serosal injury)	2.079	0.946	4.827	0.028	8.000	1.252	51.137
Preop rectoscopy specialised case (available)	0.724	0.302	5.739	0.017	2.063	1.141	3.730
Adjuvant chemotherapy-radiotherapy (yes)	0.551	0.267	4.261	0.039	1.735	1.028	2.927

SD: Standard deviation; OR: Odds ratio; CI: Confidence interval; ICU: Intensive care unit

to the marked imbalance in group sizes, potential multicollinearity between clinical variables, and limited statistical power. Therefore, the multivariate findings should be interpreted cautiously, and the univariate associations should not be overgeneralized without further validation ($p>0.05$).

Colostomy closure was performed in 108 patients, of whom 62.0% ($n=67$) were male and 38.0% ($n=41$) were female. The mean age was 54.6 ± 15.8 years, and the median was 56 (range: 18–89) years. The mean postoperative hospital stay was 12.8 ± 7.6 days (median: 11.0, range: 1–42), and ICU admission occurred in 14.8% ($n=16$) of patients, with a mean ICU stay of 4.6 ± 6.0 days and a median of 2.0 (range: 1–25). Ostomy closure timing was ≤ 12 weeks in 14.8% ($n=16$), 13–20 weeks in 24.0% ($n=26$), and >20 weeks in 61.2% ($n=66$).

The indication for ostomy creation was benign in 51.8% ($n=56$) and malignant in 48.2% ($n=52$); among benign causes, diverticular disease (28.5%), perforation (32.3%), mesenteric ischaemia (7.1%), and IBD (5.3%) were reported, while among malignancies, 73.0% ($n=38$) were colon, 23.0% ($n=12$) rectal, and 4.0% ($n=2$) other types. The ostomy configuration was tip in 79.7%, loop in 17.6%, and double-barrel in 2.7%.

Anastomosis types included colocolic (52.7%), colorectal (29.7%), ileocolic (9.2%), ileoileal (4.6%), and ileorectal (3.7%). End-to-end anastomosis was used in 73.2% of cases, followed by side-to-side (24.0%) and end-to-side (2.8%). Stapler-assisted anastomosis was performed in 80.6% ($n=87$) of cases (70.1% circular, 29.9% linear), while 19.4% ($n=21$) underwent manual anastomosis. Support sutures were used in 56.5% ($n=61$).

Intraoperative complications occurred in 23.2% ($n=25$) of patients: serosal injury (52.0%), perforation (40.0%), and

ischaemia (4.0%). Ostomy reestablishment was required in 4.7% ($n=5$), and postoperative anastomotic leakage occurred in 5.6% ($n=6$). The mean anastomosis level observed on preoperative rectoscopy was 17.7 ± 8.9 cm (median: 19.0, range: 2–40). Rectoscopy findings were absent in 68.5%, positive in 20.3%, and undocumented in 11.2% of cases.

Neoadjuvant therapy was not administered in 77.8% ($n=84$), while 22.2% ($n=24$) received it; adjuvant therapy was given to 41.7% ($n=45$), while 58.3% ($n=63$) did not receive it. The postoperative 30-day mortality rate was 3.7% ($n=4$), and morbidity occurred in 25.0% ($n=27$). According to the Clavien–Dindo classification, 66.7% ($n=18$) were Grade I, 7.4% ($n=2$) Grade IIb, and 25.9% ($n=7$) Grade V (Appendix 3).

No patients with ostomy closure ≤ 12 weeks required postoperative third-level ICU admission. In contrast, ICU admission occurred in 23.1% ($n=6$) of patients closed at 13–20 weeks and 15.2% ($n=10$) of those closed after 20 weeks. A statistically significant difference was observed in ICU admission rates among the three groups ($\chi^2=6.374$, $p=0.041$).

The indication for ostomy creation was benign in 81.3% ($n=13$) and malignant in 18.7% ($n=3$) of patients with closure ≤ 12 weeks. Among patients closed at 13–20 weeks, benign and malignant causes were each observed in 50.0% ($n=13$). For patients closed >20 weeks, 34.8% ($n=23$) had benign and 65.2% ($n=43$) had malignant causes. The difference in underlying indication according to closure time was statistically significant ($\chi^2=19.728$, $p<0.001$). No other variables showed significant differences ($p>0.05$) (Appendix 4).

Univariate logistic regression analysis revealed that the risk of late closure was 4.938 times higher in patients with malignant indications compared to those with benign conditions.

Table 2. Potential risk factors associated with late closure (>12 weeks) in univariate/multivariate logistic regression model

Variables	β	SD	Wald	p	OR	95% CI for OR	
						Bottom	Top
Postop 3 rd step ICU hospitalization (available) ^a	19.645	10048.24	0.001	0.998	3400999	0.001	–
Reason for ostomy opening ^a	1.597	0.674	5.618	0.018	4.938	1.318	18.494
Constant ^b	1.149	0.318	13.0222	<0.001	3.154	–	–
Postop 3 rd step ICU hospitalization (available) ^b	19.003	9879.74	0.001	0.998	17902297	0.001	–
Reason for ostomy opening ^b	1.308	0.681	3.694	0.055	3.699	0.974	14.042

^a: Univariate logictis regression model; ^b: Multivariate logistic regression model. SD: Standard deviation; OR: Odds ratio; CI: Confidence interval; ICU: Intensive care unit

In the colostomy group, malignancy showed a strong association with delayed closure in the univariate model; however, this effect was not maintained in multivariate analysis. The loss of significance may be due to the relatively small sample size, particularly within early and intermediate subgroups, and possible interactions between ICU admission and stoma indication. As a result, these findings should be interpreted with caution, and malignancy cannot be confirmed as an independent predictor in this cohort ($p>0.05$) (Table 2).

DISCUSSION

Ostomy creation is a critical surgical intervention performed to avert severe complications such as perforation and sepsis when intestinal integrity is compromised. It is often necessary in complex clinical scenarios including trauma, bowel obstruction, and malignancies.^[1,2] However, the optimal timing for stoma reversal remains a subject of debate and is influenced by factors such as the need for adjuvant therapy and the overall health status of the patient.

Advanced age and comorbid conditions have been shown to increase the risk of postoperative complications when ostomy closure is not properly timed.^[11,12] In the present study, we investigated the influence of timing on postoperative outcomes in patients undergoing enterostomy and colostomy closure. Our findings support patient-tailored surgical planning and provide clinically relevant insights, particularly for specific subgroups.

Among patients undergoing enterostomy closure, the majority were male (65.3%) with a mean age of 58.0 ± 14.6 years. These findings are consistent with the literature, indicating that enterostomies are more commonly required in older populations.^[13,14] Malignancy was the underlying cause in 79.0% of cases, underscoring the significant role of adjuvant treatment planning in determining closure timing. Previous reports have similarly indicated that adjuvant

chemotherapy and radiotherapy tend to delay ostomy reversal,^[15] a finding corroborated by the higher proportion of late closures in our malignancy cohort.

Notably, ICU admission following surgery was more common in the early closure group (17.8%). This suggests that early reversal may necessitate closer postoperative monitoring. However, the duration of ICU stay did not differ significantly between groups, implying that ICU admission was likely precautionary rather than indicative of increased complications. Although some studies have proposed that early reversal is associated with reduced complications, others report increased superficial surgical site infections due to transient immunosuppression from ongoing therapy.^[16,17]

The overall complication rate in the enterostomy group was 8.4%, with serosal injury (58.1%) and perforation (38.7%) being most frequent. Serosal injury was more prevalent in late closures ($p=0.045$), suggesting that prolonged stoma presence may lead to tissue fragility. This aligns with the literature indicating that long-term stomas can impair tissue integrity and necessitate advanced surgical techniques for safe reversal.^[14]

Although the mortality rate in our study was 3.1%, which is higher than that reported by Chow et al.^[18] (0.4%), our morbidity rate of 15.0% was comparable to their reported 17.3%. These findings emphasize the importance of multidisciplinary management and precise surgical scheduling to mitigate risk. The length of hospital stay was also longer in patients with delayed closure, consistent with findings by Hallböök et al.,^[19] who reported extended hospitalization in cases of postoperative complications.

Furthermore, the need for adjuvant therapy significantly delayed closure among patients with malignancies, consistent with previous research.^[15] These findings highlight the necessity of a multidisciplinary approach that balances oncologic priorities with surgical risk when determining closure timing.

Regarding colostomy closure, our data revealed a higher proportion of male patients (62.0%) with a mean age of 54.6 ± 15.8 years. Malignancy accounted for 58.2% of cases overall, and its frequency increased significantly in patients whose closure occurred after >20 weeks ($p < 0.001$), again underlining the impact of oncologic treatment planning on timing.

The complication rate was notably higher in colostomy closures (23.2%) compared to enterostomies, with serosal injury (48.2%) and perforation (40.7%) being the most frequent. These findings suggest that colostomy reversals may pose greater technical challenges and that prolonged intervals may further increase complication risk. In addition, ICU admission was most frequent in the 13–20 week group (23.1%), though ICU duration did not significantly differ. This supports prior literature suggesting that early closure may be technically difficult due to residual inflammation and edema.^[20]

Our observed anastomotic leakage rate of 5.6% falls within the 20–30% complication range reported in the literature for colostomy closure.^[21,22] This complication did not appear to be associated with timing. However, longer ostomy durations were associated with increased overall complication rates and extended hospital stays. Conversely, studies have demonstrated that early closure—especially in uncomplicated patients—can enhance quality of life and expedite social reintegration.^[21,23]

Collectively, our findings underscore the critical importance of individualized surgical timing in colostomy closure. Malignancy emerges as a major determinant of delayed reversal, and multidisciplinary coordination is essential to optimize outcomes. While early closure may be safe in carefully selected patients, meticulous preoperative planning remains essential for managing late closures and minimizing complications.

This study is subject to several inherent limitations. First, its retrospective nature and single-centre setting inherently limit the generalisability of the findings and introduce a risk of selection bias. As data were extracted from pre-existing medical records, inconsistencies or missing data entries may have influenced the accuracy and completeness of the dataset, thereby impacting the reliability of the results. Furthermore, the substantial imbalance in sample sizes between the early and late closure groups—particularly in the enterostomy cohort—reduced the statistical power of subgroup comparisons and limited the ability to detect significant differences between groups.

Another important limitation is the presence of potential confounding variables that were not accounted for or adjusted in the analysis. These include variations in surgical expertise, differences in perioperative management protocols, and surgeon-specific preferences, all of which may have influenced postoperative outcomes independent of closure timing. Additionally, patient-related factors such as nutritional status, performance status, and the presence of comorbidities—although partially recorded—were not systematically evaluated and thus may have introduced residual confounding.

Moreover, follow-up was limited to one year, and long-term outcomes such as quality of life, bowel function, and hernia development were not assessed. Future prospective multi-centre studies with standardised protocols and longer follow-up periods are warranted to validate these findings and provide more robust evidence on optimal stoma closure timing across diverse patient populations.

CONCLUSION

The study demonstrated that delayed ostomy closure was more common in patients with malignancy, largely due to the need for adjuvant therapy. Although a higher complication rate was observed in late closure, this difference was not statistically significant. Serosal injury and perforation were the most frequent complications. Preoperative rectoscopy and adjuvant treatments were found to be associated with late closure. Individualised surgical planning was shown to be effective in managing complication risk.

Disclosures

Ethics Committee Approval: The study was approved by the Umraniye Training and Research Hospital Scientific Research Ethics Committee (No: 364, Date: 17/10/2024).

Informed Consent: Informed consent was obtained from all participants.

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REFERENCES

- Cataldo PA. Technical tips for stoma creation in the challenging patient. *Clin Colon Rectal Surg* 2008;21:21–6. [\[CrossRef\]](#)
- Doughty D. Principles of ostomy management in the oncology patient. *J Support Oncol* 2005;3:59–69.
- Vignali A, Fazio VW, Lavery IC, Milsom JW, Church JM, Hull TL, et al. Factors associated with the occurrence of leaks in stapled rectal anastomoses: a review of 1,014 patients. *J Am Coll Surg* 1997;185:105–13. [\[CrossRef\]](#)
- Fasth S, Hultén L. Loop ileostomy: a superior diverting stoma in colorectal surgery. *World J Surg* 1984;8:401–7. [\[CrossRef\]](#)
- Yamaner YS. Stoma, stoma komplikasyonları ve bakımı. In: Kalaycı G, editor. *Genel Cerrahi*. İstanbul: Nobel Tıp Kitabevleri; 2002. p. 1453–70.
- Goldberg M, Aukett LK, Carmel J, Fellows J, Folkedahl B, Pittman J, et al.; Ostomy Guidelines Task Force. Management of the patient with a fecal ostomy: best practice guideline for clinicians. *J Wound Ostomy Continence Nurs* 2010;37:596–8. [\[CrossRef\]](#)
- Sherman KL, Wexner SD. Considerations in stoma reversal. *Clin Colon Rectal Surg* 2017;30:172–7. [\[CrossRef\]](#)
- Wong KS, Remzi FH, Gorgun E, Arrigain S, Church JM, Preen M, et al. Loop ileostomy closure after restorative proctocolectomy: outcome analysis in 1,504 patients. *Dis Colon Rectum* 2005;48:243–50. [\[CrossRef\]](#)
- Lee KH, Kim HO, Kim JS, Kim JY. Prospective study on the safety and feasibility of early ileostomy closure 2 weeks after lower anterior resection for rectal cancer. *Ann Surg Treat Res* 2019;96:41–6. [\[CrossRef\]](#)
- Horeh N, Rudnicki Y, Dreznik Y, Zbar AP, Gutman M, Zmora O, et al. Reversal of Hartmann's procedure: still a complicated operation. *Tech Coloproctol* 2018;22:81–7. [\[CrossRef\]](#)
- Korkut MA, Aynacı M. Intestinal stomalar (ileostomi, kolostomi). In: Gülay H, editor. *Temel Cerrahi*. İzmir: Güven Kitabevi; 2005. p. 1453–70.
- Isbister WH, Prasad M. The management of left-sided large bowel obstruction: an audit. *Aust N Z J Surg* 1996;66:602–4. [\[CrossRef\]](#)
- Tulchinsky H, Shacham-Shmueli E, Klausner JM, Inbar M, Geva R. Should a loop ileostomy closure in rectal cancer patients be done during or after adjuvant chemotherapy? *J Surg Oncol* 2014;109:266–9. [\[CrossRef\]](#)
- Sier MF, van Gelder L, Ubbink DT, Bemelman WA, Oostenbroek RJ. Factors affecting timing of closure and non-reversal of temporary ileostomies. *Int J Colorectal Dis* 2015;30:1185–92. [\[CrossRef\]](#)
- Chau TC, Nguyen H, Robertson IK, Harvey X, Tan B, Tan M, et al. Factors affecting timing of loop ileostomy closure: a regional centre's experience with 106 patients. *ANZ J Surg* 2024;94:193–8. [\[CrossRef\]](#)
- Sauri F, Sakr A, Kim HS, Alessa M, Torky R, Zakarneh E, et al. Does the timing of protective ileostomy closure post-low anterior resection have an impact on outcomes? A retrospective study. *Asian J Surg* 2021;44:374–9. [\[CrossRef\]](#)
- Vaughan-Shaw PG, Gash K, Adams K, Vallance AE, Pilkington SA, Torkington J, et al. Protocol for a multicentre, dual prospective and retrospective cohort study investigating timing of ileostomy closure after anterior resection: the CLOSURE of Ileostomy Timing (CLOSE IT) study. *BMJ Open* 2018;8:e023305. [\[CrossRef\]](#)
- Chow A, Tilney HS, Paraskeva P, Jeyarajah S, Zacharakis E, Purkayastha S. The morbidity surrounding reversal of defunctioning ileostomies: a systematic review of 48 studies including 6,107 cases. *Int J Colorectal Dis* 2009;24:711–23. [\[CrossRef\]](#)
- Hallböök O, Matthiessen P, Leinsköld T, Nyström PO, Sjödaahl R. Safety of the temporary loop ileostomy. *Colorectal Dis* 2002;4:361–4. [\[CrossRef\]](#)
- Keck JO, Collopy BT, Ryan PJ, Fink R, Mackay JR, Woods RJ. Reversal of Hartmann's procedure: effect of timing and technique on ease and safety. *Dis Colon Rectum* 1994;37:243–8. [\[CrossRef\]](#)
- Khoury DA, Beck DE, Opelka FG, Hicks TC, Timmcke AE, Gathright JB Jr. Colostomy closure: Ochsner Clinic experience. *Dis Colon Rectum* 1996;39:605–9. [\[CrossRef\]](#)
- Resio BJ, Jean R, Chiu AS, Pei KY. Association of timing of colostomy reversal with outcomes following Hartmann procedure for diverticulitis. *JAMA Surg* 2019;154:218–24. [\[CrossRef\]](#)
- Khalid MS, Moeen S, Khan AW, Arshad R, Khan AFA. Same admission colostomy closure: a prospective, randomised study in selected patient groups. *Surgeon* 2005;3:11–4. [\[CrossRef\]](#)

Appendix 1. Demographic and clinical characteristics of patients with enterostomy closure

	Enterostomy (n=366)			Enterostomy (n=366)	
	n	%		n	%
Sex			If anastomosis is with stapler type		
Male	239	65	Circular	13	3.8
Female	127	34	Linear	326	96
Age (years)			Presence of support strut?		
Mean±SD	58.1±14.5		None	108	29
Median (min-max)	60 (17-92)		Yes	258	70
Postoperative hospitalization period (days)			Existence of intraoperative complication?		
Mean±SD	11.7±8.2		None	335	91
Median (min-max)	9 (2-64)		Yes	31	8.4
ICU stay duration			Type of complication developed during ostomy closure		
None	326	89	Serosal injury	18	58
Yes	40	11	Perforation	12	38
ICU stay duration (days)			Obstruction	1	3.2
Mean±SD	2.7±1.9		Re-ostomy indicated during closure?		
Median (min-max)	2 (1-10)		None	356	97
Duration of ostomy closure			Yes	10	2.8
≤12 weeks	101	27	Preop rectoscopy anastomosis level (cm)		
>12 weeks	265	72	Mean±SD	7.38±6.04	
Reason for ostomy opening			Median (min-max)	6.0 (1-40)	
Benign	77	21	Preop rectoscopy featured condition		
Malignant	289	79	None	235	64
If benign, cause			Yes	98	26
Diverticular disease	1	1.3	Unknown	33	9.1
IBD	30	39	Conditions detected at rectoscopy		
Perforation	28	36	Polyp	32	32
Mesentery ischemia	9	11	Obstruction	23	23
Other	9	11	Diversion Colitis	10	10
If malignant, cause			Fistula	8	8.1
Colon	50	17	Nonspecific Colitis	7	7.1
Rectum	229	79	Other	18	19
Other	10	3	Neoadjuvant chemotherapy-radiotherapy		
Ostomy type			None	305	83
End	38	10	Yes	61	16
Loop	313	85	Adjuvant chemotherapy-radiotherapy		
Double barrel	15	4	None	249	68
Anastomosis type			Yes	117	32
Ileoileal	320	87	Mortality		
Ileocolic	32	8.8	None	355	96
Colorectal	2	0.5	Yes	11	3.1
Ileorectal	5	1.4	Morbidity		
Jejunocolic	2	0.5	None	311	85
Jejunojejunal	5	1.4	Yes	55	15
Anastomosis direction			Clavien dindo classification		
End to end	36	9.8	1	27	49
End to side	12	3.3	2	10	18
Side to side	318	87	3	1	1.9
Anastomosis technique			3a	1	1.9
Hand assisted	27	7.3	3b	6	11
Stapled	339	92	4b	2	3.6
			5	8	14

SD: Standard deviation; ICU: Intensive care unit; IBD: Inflammatory bowel disease

Appendix 2. Comparison of demographic and clinical parameters according to the timing of enterostomy closure

	≤12 weeks (n=101)		>12 weeks (n=265)		Test statistic	
	n	%	n	%	a;b	p
Sex						
Male	61	60	178	67	a=1.481	0.224
Female	40	39	87	32		
Age						
Mean±SD	60.29±15.90		57.22±14.05		b=2.110	0.035
Median (min-max)	62.0 (17-87)		59.0 (19-92)			
Duration of postoperative hospitalization (days)						
Mean±SD	12.56±9.54		11.49±7.70		b=0.208	0.835
Median (min-max)	8.0 (2-45)		9.0 (2-64)			
ICU stay duration						
None	83	82	243	91	a=6.808	0.009
Yes	18	17	22	8.3		
ICU stay duration (days)						
Mean±SD	2.72±1.64		2.68±2.21		b=0.891	0.411
Median (min-max)	2.0 (1-8)		2.0 (1-10)			
Reason for ostomy opening						
Benign	25	24	52	19	a=1.158	0.282
Malignant	76	75	213	80		
Cause if benign						
IBD	6	24	24	46	a=6.433	0.092
Perforation	12	48	16	30		
Mesentery ischemia	5	20	4	7.7		
Other	2	8	8	15		
Cause if malignant						
Colon	13	17	37	17	a=10.258	0.006
Rectum	56	73	173	81		
Other	7	9.2	3	1.4		
Ostomy type						
End	9	8.9	29	11	a=0.340	0.844
Loop	88	87	225	85		
Double barrel	4	4	11	4.2		
Anastomosis type						
Ileoileal	88	87	232	87	a=8.636	0.076
Ileocolic	8	7.9	24	9		
Colorectal	0	0	2	0.8		
Ileorectal	0	0	5	1.9		
Jejunocolic	2	2	0	0		
Jejunojejunal	3	3	2	0.8		
Anastomosis direction						
End to end	6	5.9	30	11	a=2.476	0.290
End to side	3	3	10	3.7		
Side to side	92	91	226	85		
Anastomosis technique						
Hand assisted	8	7.9	19	7.2	a=0.060	0.806
Stapled	93	92	246	93		
If anastomosis is with stapler type						
Circular	3	3.2	10	4.1	a=0.129	0.720
Linear	90	96	236	95		

Appendix 2. Cont.

	≤12 weeks (n=101)		>12 weeks (n=265)		Test statistic	
	n	%	n	%	a;b	p
Presence of support strut?						
None	24	24	84	32	a= 2.214	0.137
Yes	77	76	181	68		
Existence of intraoperative complication?						
None	93	92	242	91	a=0.054	0.816
Yes	8	7.9	23	8.7		
Type of complication during ostomy closure						
Serosal Injury	2	25	16	69	a=6.210	0.045
Perforation	6	75	6	26		
Obstruction	0	0	1	4.3		
Re-ostomy indicated during closure?						
None	98	97	258	97	–	0.553 (c)
Yes	3	3	7	2.6		
Anastomosis level						
Mean±SD	7.08±6.14		7.46 ± 6.05		b=0.858	0.391
Median (min-max)	5.0 (1–35)		6.0 (1–40)			
Preop						
None	71	70	164	61	a=8.256	0.016
Yes	17	16	81	30		
Unknown	13	13	20	7.5		
Conditions detected at rectoscopy						
Polyp	6	30	26	33	a=1.152	0.949
Obstruction	5	25	18	23		
Diversion colitis	2	10	8	10		
Fistula	1	5	7	8.9		
Nonspecific colitis	1	5	6	7.7		
Other	5	25	13	16		
Neoadjuvant chemotherapy-radiotherapy						
None	84	83	221	83	a=0.003	0.958
Yes	17	16	44	16		
Adjuvant chemotherapy-radiotherapy						
None	77	76	172	65	a=4.318	0.038
Yes	24	23	93	35		
Mortality						
None	97	96	258	97	–	0.504 (c)
Yes	4	4	7	2.7		
Morbidity						
None	80	79	231	87	–	0.071 (c)
Yes	21	20	34	13		
Clavien dindo classification						
1	10	64	17	29	a=9.931	0.128
2	3	9.6	7	29		
3	1	3.2	0	0		
3a	0	0	1	4.1		
3b	3	9.7	3	12		
4b	2	6.5	0	0		
5	2	6.5	6	25		

a: Chi-squared Test; b: Mann Whitney U Test; c: Fisher Exact test results are given. SD: Standard deviation; ICU: Intensive care unit; IBD: Inflammatory bowel disease

Appendix 3. Demographic and clinical characteristics of patients with colostomy closure

	Colostomy (n=108)			Colostomy (n=108)	
	n	%		n	%
Sex			Anastomosis direction		
Female	67	62	Side to side	26	24
Male	41	38	Anastomosis technique		
Age (year)			Hand assisted	21	19
Mean±SD	54.62±15.82		Stapled	87	80
Median (min-max)	56.0 (18–89)		If anastomosis is with stapler type		
Duration of postoperative hospitalization (days)			Circular	61	70
Mean±SD	12.76±7.58		Linear	26	30
Median (min-max)	11.0 (1–42)		Presence of support strut?		
ICU stay duration			None	47	43
None	92	85	Yes	61	56
Yes	16	15	Existence of intraoperative complication?		
ICU stay duration (days)			None	83	76
Mean±SD	4.59±6.04		Yes	25	24
Median (min-max)	2.0 (1–25)		Type of complication during ostomy closure		
Duration of ostomy closure			Haemorrhage	1	4
≤12 weeks	16	15	Serosal injury	13	52
13–20 weeks	26	24	Ischemia	1	4
>20 weeks	66	61	Perforation	10	40
Reason for ostomy opening			Re-ostomy indicated during closure?		
Benign	56	52	None	103	95
Malignant	52	48	Yes	5	4.7
If benign, cause			Preop rectoscopy anastomosis level (cm)		
Diverticular disease	16	28	Mean±SD	17.65±8.93	
IBD	3	5.3	Median (min-max)	19.0 (2–40)	
Perforation	18	32	Preop rectoscopy featured condition		
Mesentery ischemia	4	7.1	None	74	68
Other	15	27	Yes	22	20
If malignant, cause			Known	12	11
Colon	38	73	Neoadjuvant chemotherapy-radiotherapy		
Rectum	12	23	None	84	77
Other	2	4	Yes	24	23
Ostomy type			Adjuvant chemotherapy-radiotherapy		
End	86	79	None	63	58
Loop	19	17	Yes	45	42
Double barrel	3	2.7	Mortality		
Anastomosis type			None	104	96
Ileoileal	5	4.6	Yes	4	3.7
Ileocolic	10	9.2	Morbidity		
Colocolic	57	52	None	81	75
Colorectal	32	30	Yes	27	25
Ileorectal	4	3.8	Clavien dindo classification		
Anastomosis direction			1	18	66
End to end	79	73	3b	2	7.4
End to side	3	2.8	5	7	26

SD: Standard deviation; ICU: Intensive care unit; IBD: Inflammatory bowel disease

Appendix 4. Comparison of demographic and clinical characteristics of patients with colostomy closure according to the duration of ostomy closure

	Ostomy closure time							
	≤12 weeks (n=16)		13–20 weeks (n=26)		>20 weeks (n=66)		Test statistic	
	n	%	n	%	n	%	a,b,c	p
Sex								
Male	11	69	20	77	36	55	a=4.325	0.115
Female	5	31	6	23	30	45		
Age								
Mean±SD	58.88±16.45		49.35±16.65		55.26±15.26		b=3.631	0.163
Median (min-max)	56.5 (28–85)		49.5 (19–84)		56.0 (19–89)			
Duration of postoperative hospitalization (days)								
Mean±SD	12.88±5.69		11.92±7.69		13.20±8.05		b=1.060	0.589
Median (min-max)	13.0 (6–22)		9.0 (4–40)		12.0 (1–42)			
ICU stay duration								
None	16	100	20	77	56	85	a=6.374	0.041
Yes	0	0	6	23	10	15		
ICU stay duration (days)								
Mean±SD	–		–4.17±1.72		5.10±7.88		c=1.654	0.118
Median (min-max)	–		– 4.0 (2–7)		2.0 (1–25)			
Reason for ostomy opening								
Benign	13	81	20	77	23	34	a=19.728	<0.001
Malignant	3	19	6	23	43	66		
If benign, the reason is								
Diverticular disease	5	38	7	35	4	17	a=9.640	0.291
IBD	0	0	1	5	2	8.7		
Perforation	4	31	8	40	6	26		
Mesentery ischemia	2	15	1	5	1	4.3		
Other	2	16	3	15	10	43		
If malignant, the reason is								
Colon	2	67	5	83	31	72	a=1.105	0.893
Rectum	1	33	1	17	10	23		
Other	0	0	0	0	2	4.7		
Ostomy type								
End	12	76	19	73	55	83	a=6.707	0.152
Loop	2	12	7	27	10	15		
Double barrel	2	12	0	0	1	1.5		
Anastomosis type								
Ileoileal	0	0	3	11	2	3	a=8.621	0.375
Ileocolic	3	19	1	3.8	6	9.2		
Colocolic	8	50	16	61	33	50		
Colorectal	4	25	5	19	23	34		
Ileorectal	1	6.3	1	3.8	2	3		
Anastomosis direction								
End to end	11	68	22	84	46	69	a=3.151	0.533
End to side	1	6.3	0	0.0	2	3.1		
Side to side	4	25	4	16	18	27		

Appendix 4. Cont.

	Ostomy closure time							
	≤12 weeks (n=16)		13–20 weeks (n=26)		>20 weeks (n=66)		Test statistic	
	n	%	n	%	n	%	a,b,c	p
Anastomosis technique								
Hand assisted	4	25	7	27	10	15	a=2.020	0.364
Stapled	12	75	19	73	56	85		
Type if anastomosis with stapler								
Circular	8	67	15	79	38	68	a=0.912	0.634
Linear	4	33	4	21	18	32		
Presence of support strut?								
None	5	31	10	38	32	48	a=1.913	0.384
Yes	11	69	16	62	34	52		
Existence of intraoperative complication?								
None	14	88	18	69	51	77	a=1.875	0.392
Yes	2	12	8	31	15	23		
Type of complications during ostomy closure								
Serosal injury	1	50	5	63	7	47	a=2.348	0.672
Perforation	1	50	3	37	6	40		
Other	0	0	0	0.0	2	13		
Re-ostomy indicated during closure?								
None	15	94	25	96	63	95	a=0.125	0.939
Yes	1	6	1	3.8	3	4.5		
Preop rectoscopy anastomosis level (cm)								
Mean±SD	17.50±9.12		18.00±7.57		17.87±9.65		b=0.053	0.974
Median (min-max)	19.0 (2–30)		20.0 (2–30)		18.0 (3–40)			
Preop rectoscopy featured condition								
None	11	69	18	69	45	69	a=8.364	0.079
Yes	3	19	8	31	11	16		
Unknown	2	12	0	0.0	10	15		
Neoadjuvant chemotherapy-radiotherapy								
None	12	75	16	62	56	85	a=5.948	0.051
Yes	4	25	10	38	10	15		
Adjuvant chemotherapy-radiotherapy								
None	9	56	12	46	42	64	a=2.379	0.304
Yes	7	44	14	54	24	36		
Mortality								
None	16	100	26	100	62	94	a= 2.643	0.267
Yes	0	0	0	0	4	6		
Morbidity								
None	13	81	18	69	50	76	a= 0.815	0.665
Yes	3	19	8	31	16	24		
Clavien dindo classification								
1	3	100	4	50	11	68	a= 2.571	0.632
3b	0	0	1	12	1	6.2		
5	0	0	3	38	4	25		

a: Chi-squared Test; b: Kruskal Wallis Test; c: Mann Whitney U Test