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Preoperative and intraoperative predictive factors affecting to the time interval of stoma closure in patients at Dr. Sardjito General Hospital, Yogyakarta in 2018-2023

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ABSTRACT

Ostomy procedures, frequently indicated for malignancies, significantly impact patient well-being. In certain instances, stoma closure becomes imperative. Despite the lack of consensus regarding the optimal timeframe for temporary stoma closure, this study aimed to delineate predictors associated with the closure timing, thereby enhancing prognostic precision and augmenting patient care strategies. A cross-sectional study was conducted at Dr. Sardjito General Hospital, Yogyakarta, analyzing medical records of patients who underwent primary stoma creation and subsequent closure between January 2018 and December 2023. Factors, including preoperative, disease-related, and intraoperative variables, were analyzed using SPSS version 26.0. Bivariate and multivariate analyses were performed to identify predictors for stoma closure duration. In the colostomy group, body mass index (BMI), underlying disease, and complications were significantly associated with duration of stoma closure by bivariate analysis (p=0.016; 0.036; 0.040), and BMI and hemoglobin level associated with duration of closure by multivariate analysis (p=0.010; 0.044). Increasing BMI, disease stage, chemotherapy use, complications, and lower hemoglobin level predicted a longer closure duration, while chemotherapy reduced the risk. In the ileostomy group, factors such as underlying disease, cancer stage, chemotherapy status, complications, and type of surgery were associated with duration of closure by bivariate analysis (p=0.010; 0.024; 0.002; 0.013; 0.034), with complications associated with duration of closure by multivariate analysis (p=0.008). In conclusion, BMI, underlying diseases, and complications are associated with stoma closure duration. Understanding these factors can aid in risk stratification and optimizing patient management strategies during stoma closure surgeries.

ABSTRAK

Prosedur ostomi, yang sering diindikasikan untuk keganasan, berpengaruh signifikan terhadap kesejahteraan pasien. Pada kasus-kasus tertentu, penutupan stoma menjadi sangat penting. Meskipun belum ada konsensus mengenai jangka waktu optimal untuk penutupan stoma sementara, penelitian ini bertujuan untuk menggambarkan prediktor yang mempengaruhi waktu penutupan, sehingga meningkatkan ketepatan prognosis dan menambah strategi perawatan pasien._Sebuah studi *cross sectional* retrospektif dilakukan di RSUP Dr. Sardjito, Yogyakarta, dengan menganalisis rekam medis pasien yang menjalani pembuatan stoma primer dan penutupan stoma antara Januari 2018 dan Desember 2023. Faktor-faktor yang meliputi variabel pra operasi, terkait penyakit, dan intra operasi dianalisis menggunakan SPSS versi 26.0. Analisis bivariat dan multivariat dilakukan untuk mengidentifikasi faktor prediktif untuk durasi penutupan stoma. Pada kelompok kolostomi, indeks massa tubuh (IMT), penyakit yang mendasari, dan komplikasi secara signifikan berhubungan dengan durasi penutupan stoma (p=0,016; 0,036; 0,040) dari hasil analisis bivariat, dengan IMT dan kadar hemoglobin berhubungan dengan durasi penutupan (p=0,010; 0,044) dari hasil analisis multivariat. Peningkatan IMT, stadium penyakit, penggunaan kemoterapi, komplikasi, dan kadar hemoglobin yang lebih rendah memprediksi durasi penutupan yang lebih lama, sementara kemoterapi mengurangi risiko tersebut. Pada kelompok ileostomi, faktor-faktor seperti penyakit yang mendasari, stadium kanker, status kemoterapi, komplikasi, dan jenis operasi berhubungan dengan durasi penutupan (p=0,010; 0,024; 0,002; 0,013; 0,034) dari hasil analisis bivariat, dengan komplikasi berhubungan dengan durasi penutupan dari hasil analisis multivariat. Simpulan, faktor IMT, penyakit yang mendasari, dan komplikasi pasien mempengaruhi durasi penutupan stoma pasien. Memahami faktor-faktor ini dapat membantu dalam stratifikasi risiko dan mengoptimalkan strategi manajemen pasien selama operasi penutupan stoma.

Keywords:
closure;
timing;
stoma;
predictive factor

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INTRODUCTION

An ostomy is a surgical procedure that involves creating an opening in a hollow organ connecting it to the body's surface to facilitate the excretion of waste products. An enterostomy refers specifically to an ostomy performed on the intestines, whether the small intestine (ileostomy) or the large intestine (colostomy). The most common indication for an ostomy procedure is malignancy. However, this procedure is a major surgery that can significantly impact the patient's quality of life.[1]

A systematic review of 18 randomized controlled trial (RCTs) found that ostomy procedure complications range from 2.9% to 81.1%, primarily involving peristomal skin and hernia.[2] Among 616 patients with temporary ostomies, 19% became permanent, with delays in closure linked to advanced age, secondary stomas, end stoma colostomy or ileostomy, and postoperative complications.[3] Meta-analyses indicate that permanent stomas are associated with advanced age (>65 yr), severe comorbidities (characterized as American Society of Anesthesiologists (ASA) status >2), postoperative complications, anastomotic insufficiency, and advanced malignancy.[4]

Currently, there is no consensus on the optimal timing for temporary stoma closure. One study suggests that closure can be performed after 8-12 wk, by which time inflammation resolution, postoperative recovery, and adhesion softening are expected. The study by Guo *et al*.[5] indicates that stoma closure can be performed as early as 4 wk post-colorectal resection, although there is a higher incidence of surgical wound complications compared to routine closure procedures performed around the 8th week post-colorectal resection. In contrast, a study by Krebs *et al*.[6] suggests that temporary stoma closure performed less than 8 mo post-surgery has fewer complications.

A retrospective cohort study conducted in India, examining 102 patients who underwent temporary stoma creation, found that 77 patients underwent reversal on day 74.47 on average, while 25 patients could not undergo reversal. Fifty-one patients received reversal only after a second surgery (secondary operation). Factors contributing to the delay include loop ileostomy, adjuvant chemotherapy, intra-abdominal sample collection, and secondary stoma creation.[7]

Given these considerations, it would be highly beneficial to identify predictors that clarify the prognosis for stoma closure timing. This could lead to the development of tools to guide predictions and provide patient education on stoma (colostomy/ileostomy) management plans. Therefore, this study aims to determine the factors associated with the timing of stoma closure.

MATERIALS AND METHODS

Design and subjects

This retrospective cohort study was conducted at Dr. Sardjito General Hospital in Yogyakarta, Indonesia utilizing medical records. The study included patients who underwent primary stoma creation and subsequent closure between January 2018 and December 2023. Patients over 18 yo with complete medical records, excluding those with primary surgeries at other hospitals, deceased before stoma closure, or had permanent stomas, were analyzed. The minimum number of samples required based on the rule of thumb calculation with the sample size is 10 times larger than the research variable (Roscoe, 1975), so the required sample is 14 variables multiplied by 10 is 140 subjects.

Data collection

The analyzed factors included preoperative variables (age, sex, BMI, American Society of Anesthesiologists (ASA) status, chemotherapy status),

disease-related variables (comorbidities, etiology, cancer stage), and intraoperative variables (operation duration, hospital stay length, stoma creation urgency, postoperative complications). These factors were assessed before the stoma closure as the cohort nature of this study. Stoma closure intervals were considered as dependent variable and categorized using the median and analyzed separately for each colostomy and ileostomy groups.

Statistical analysis

Data were analyzed using SPSS for Windows version 26.0. Descriptive statistics, including means, standard deviations, medians, counts, and percentages, were used to summarize the data. Normality tests were performed, and stoma closure intervals were analyzed using chi-square. Bivariate analysis identified predictor factors with odds ratios (OR) and 95% confidence intervals (CI). Variables with $p<0.25$ in bivariate analysis were included in multivariate analysis, with significance set at $p<0.05$, to identify predictive factors using logistic regression, indicated by OR values.

RESULTS

Univariate analysis results

This study involved 140 patients, with a mean age of 50.03±13.9 yr, evenly distributed between sex. Comorbidities were present in 33 patients, with the majority having malignant diseases (94 patients; 69.3%). Patients were divided into colostomy and ileostomy groups, each consisting of 70 samples. Stoma creation typically lasted 4 hr, with 107 elective procedures (76.4%) and 33 emergent procedures (23.6%). Detailed patient characteristics are provided in the accompanying TABLE 1.

In this study, patients had a mean postoperative hospital stay of 7.12 d (median 7 d). Complications occurred in 23 patients post-stoma creation. Among them, 17 patients experienced Clavien-Dindo classification (CDC) grade 2 complications, including septic shock (13), wound dehiscence (3), and stoma prolapse (1). Additionally, 16 patients had CDC grade 3 complications, such as anastomotic leakage with severe adhesions (4), cecal leakage (1), and relaparotomy (11). The mean stoma closure interval was 270±193 d with a median of 236 d. Among all variables, only ASA status differed significantly between patients undergoing colostomy and ileostomy. However, other variables showed no significant differences between the two groups.

In the colostomy group, the median age was 51.5 yr (IQR 41-59), with the majority being male (36/70). Most patients had normal BMI (47.1%) and a single comorbidity (18.6%). Malignant diseases primarily drove colostomy procedures, with the majority being in stage III (42.9%) and receiving chemotherapy (68.6%). Elective procedures predominated (81.4%) with a median stoma creation duration of 4 hr (IQR 4-5). After colostomy, the median hospital stay was 8 d (IQR 7-8). Complications occurred in 17 patients, mainly CDC grade 2 (7 patients) and grade 3 (10 patients). The median closure interval for colostomy was 284 d (IQR 208-346). Conversely, in the ileostomy group, the median age was also 51.5 yr (IQR 43-63), with the majority being female (36/70). Most patients had a normal BMI (50%) and no comorbidities (78.6%). Malignant diseases also predominated (78.6%), mainly in stage III (38.6%) and receiving chemotherapy (65.7%). Elective procedures were common (71.4%) with a median stoma creation duration of 4 hr (IQR 3-5). After ileostomy, the median hospital stay was 6 d (IQR 5-7). Complications occurred in 16 patients, primarily CDC grade 2 (10 patients) and grade 3 (6 patients). The median closure interval for ileostomy was 176 d (IQR 101-289). Notably, closure intervals were shorter in patients with non-malignant underlying diseases compared to those with malignant diseases.

TABLE 1. Characteristics of study subjects

Variable	Overall		Intervention		p
	n	%	Colostomy	Ileostomy	
			n	n	
Age (yr)					
• ≤ 51	71	50.7	35	36	1.000
• >51	69	49.3	35	34	
Sex					
• Male	70	50	36	34	0.866
• Female	70	50	34	36	
BMI					
• Underweight	39	20.7	13	16	
• Normal	68	48.6	33	35	0.799
• Overweight	19	13.6	11	8	
• Obese	24	17.1	13	11	
ASA status					
• ASA I	32	22.9	13	19	0.028
• ASA II	102	72.8	51	51	
• ASA III	6	4.3	6	0	
Chemotherapy status					
• No	46	32.9	22	24	0.857
• Yes	94	67.1	48	46	
Comorbidity					
• None	107	76.4	52	55	0.732
• Single	25	17.9	13	12	
• Multiple	8	5.7	5	3	
Underlying disease					
• Non malignant	43	30.7	21	22	1.000
• Malignant	94	69.3	49	48	
Stadium					
• 0	42	30.0	19	21	
• I	1	0.8	1	0	0.716
• II	31	22.1	16	15	
• III	56	40.0	30	27	
• IV	10	7.1	4	7	
Stoma creation time (hr)					
• ≤4	75	53.6	37	38	1.000
• >4	65	46.4	33	32	
Type of surgery					
• Elective	107	76.4	57	50	0.232
• Emergencies	33	23.6	13	20	
Length of hospitalization (d)					
• ≤7	85	60.7	54	55	1.000
• >7	55	39.3	16	15	
Complications					
• None	107	76.4	53	54	0.463
• CDC 2	17	12.2	7	10	
• CDC 3	16	11.4	10	6	
Stoma closure interval (d)					
• ≤236	69	49.3	35	34	1.000
• >236	71	50.7	35	36	

Abbreviations: American Society of Anesthesiologists (ASA); body mass index (BMI); Clavien-Dindo classification (CDC)

TABLE 2. Results of bivariate analysis between variables with stoma closure interval

Variable	Colostomy closure interval		p	OR	Ileostomy closure interval		p	OR
	≤284 d	>284 d			≤284 d	>284 d		
Age (yr)								
• ≤ 51	19	16	0.633	1.410	19	17	0.485	1.416
• >51	16	19			15	19		
Sex								
• Male	20	16	0.473	1.583	15	19	0.485	0.706
• Female	15	19			19	17		
BMI								
• Underweight	10	3			9	7		
• Normal	18	15	0.016*		18	17	0.476	
• Overweight	5	6			4	4		
• Obese	2	11			3	8		
Comorbid								
• None	26	26	0.288		28	17	0.730	
• Single	5	8			5	7		
• Multiple	4	1			1	2		
Underlying disease								
• Non malignant	15	6	0.036*	3.625	16	6	0.010*	4.444
• Malignant	20	29			18	30		
Stadium								
• 0	13	6			16	5		
• I	0	1	0.359		0	0	0.024*	
• II	7	9			6	9		
• III	13	17			10	17		
• IV	2	2			2	5		
Status ASA								
• ASA I	9	4	0.299		11	8	0.424	1.674
• ASA II	23	28			23	28		
• ASA III	3	3						
Chemotherapy Status								
• No	15	7	0.070	3.000	18	6	0.002*	5.625
• Yes	20	28			16	30		
Length of hospitalization (d)								
• ≤6/7	26	28	0.777	0.722	20	23	0.807	0.807
• >6/7	9	7			14	13		
Complications								
• None	31	22	0.040*		31	23	0.013*	
• CDC 2	2	5			3	7		
• CDC 3	2	8			0	6		
Stoma creation time (hr)								
• ≤4	17	20	0.632	0.708	22	16	0.100	2.292
• >4	18	15			12	20		
Type of surgery								
• Elective	28	29	1.000	0.828	20	30	0.034*	0.286
• Emergencies	7	6			14	6		
Albumin								
• ≤4.1	20	25	0.318	0.533	22	16	0.100	2.292
• >4.1	15	10			12	20		
Hemoglobin (g/dL)								
• ≤12.4	14	7	0.117	2.667	19	18	0.641	1.267
• >12.4	21	28			15	18		

p<0.05 was statistically significant; variables with p<0.25 were underwent to multivariate analysis

Bivariate and multivariate analysis

The results indicate that BMI, underlying disease, and complications are associated with the duration of colostomy closure interval (p=0.016; 0.036; 0.040, respectively). Similarly, in the ileostomy group, bivariate analysis was conducted to examine the relationship between closure interval duration and several predictor factors (TABLE 2). The findings reveal that underlying disease, cancer stage, chemotherapy status, complications, and type of surgery are associated with the duration of stoma closure interval (p=0.010; 0.024; 0.002; 0.013; 0.034, respectively).

Variables that show a p <0.25 in the bivariate analysis then proceed to multivariate analysis (TABLE 3). In the colostomy group, significant predictors included BMI, underlying disease, chemotherapy status, complications, and hemoglobin levels, with BMI and hemoglobin levels associated with closure duration (p = 0.010 and 0.044, respectively). For ileostomy, significant predictors comprised underlying disease, cancer stage, chemotherapy status, operation duration, surgery type, complications, and patient albumin levels, with only complications was associated with closure duration (p = 0.008). Overall, an increase in disease stage, chemotherapy use, operation duration, and albumin levels increased the risk of prolonged ileostomy closure, while non-malignant underlying diseases and elective surgery types reduced this risk.

TABLE 3. Results of multivariate analysis between variables with stoma closure interval

Variable	Sig.	OR	95% CI	
			Lower	Upper
Colostomy group				
BMI	.010*	2.284	1.223	4.264
Underlying disease	1.000	2.607	0.000	.
Chemotherapy status	1.000	0.000	0.000	.
Complication	0.063	1.691	0.971	2.944
Hemoglobin level	0.044*	3.838	1.036	14.222
Constant	0.002	0.015		
Ileostomy group				
Underlying disease	0.338	0.193	0.007	5.594
Malignancy stadium	0.224	1.914	0.673	5.448
Chemotherapy status	0.720	1.635	0.111	24.137
Duration of surgery	0.215	2.275	0.620	8.343
Complication	0.008*	2.969	1.333	6.611
Type of surgery	0.519	0.486	0.054	4.359
Albumin	0.053	3.192	0.983	10.361
Constant	0.025	0.027		

p<0.05 is considered as significant

DISCUSSION

Many patients undergo temporary ostomy formation for conditions like inflammatory bowel disease, colorectal cancer, and diverticular disease.[8] The primary goals are to improve quality of life, treat pathological conditions, or prevent postoperative complications like anastomotic leakage.[9] Closure of a temporary stoma should be delayed until surrounding edema and induration subside and the bowel appears normal. Patency of the distal anastomosis must be confirmed with fluoroscopy. Ostomy closure can be scheduled when the intestinal anastomosis or ileoanal pouch has healed, acute inflammation has subsided, and post-resection edema has resolved. The timing was also affected by the patient's psychological and physical recovery from the initial surgery. Typically, stoma closure occurs after eight to twelve weeks, but it carries a risk of complications.[10,11]

This study identified risk factors and predictors affecting ostomy closure time were identified in the colostomy and ileostomy groups. In this study, 70 colostomy and 70 ileostomy procedures were performed, with a mean patient age of 50.03 ± 13.9 yr. The patient cohort consisted of 70 males (50%) and 70 females (50%), resulting in a male-to-female ratio of 1:1. The majority of patients had a normal BMI, ASA status II.

In our cohort, over 50% of the patients had cancer as the primary etiology, with a malignancy-to-non-malignancy ratio of 7:3. Consequently, most patients received chemotherapy. This aligns with the common indication of malignancy among ostomy recipients. More than 50% of patients presented at cancer stage 0 and had no comorbidities. The majority of ostomy procedures were elective, with stoma creation times of ≤4 hr, and most patients had hospital stays of ≤7 d. Additionally, more than 76.4% of patients experienced no complications. The mean duration for stoma closure in this study was 270 ± 193 d.

Cancer and related complications are the most common indications for ostomy, followed by diverticular disease, inflammatory bowel disease, trauma, gastrointestinal perforation, radiation effects, distal anastomosis protection, and management of anastomotic leaks.[12] Colorectal cancer is the leading cause of both colostomy and ileostomy in this study, followed by other cancers such as ovarian and cervical cancer. The overall cancer morbidity and mortality ratio by sex is 1:1.[13] These findings are consistent with previous studies.

Colorectal cancer is the third most common cancer globally (1.80 million cases), the second most common in women (0.79 million cases), and the third most common in men (0.98 million cases). Its incidence increases by 1% annually among those aged 50-64 yr. In Indonesia, colorectal cancer predominantly occurs in individuals over 50 yo.[14] In this study, the mean age of patients was above 50 yr.

Between colostomy and ileostomy procedures, the only differing variable was ASA status. The colostomy group had a higher prevalence of ASA II and ASA III status (81% vs. 73%). No other variables differed between the two groups.

Inflammation is closely associated with cancer development and progression. External tumor inflammation can be triggered by factors like infections, autoimmune diseases, obesity, smoking, asbestos exposure, and excessive alcohol consumption, all raising cancer risk. Conversely, cancer-induced inflammation results from cancer-triggering mutations, aiding malignancy by activating inflammatory cells. This impacts patient cancer stages, clinical conditions, and ASA status, which predicts surgical risk.[15,16]

In this study, colostomy was observed in 49 out of 70 patients with malignancies, with a mean cancer stage of III; 42 of

these patients exhibited ASA II/III status. Among non-malignancy colostomy recipients, trauma was identified as the etiology in 21 patients, presenting with a spectrum of conditions including sigmoid perforation, rectovaginal fistula, intestinal tuberculosis, obstructive ileus, sigmoid volvulus, proctitis, diverticulosis, anal stricture, colitis, Fournier gangrene, retroperitoneal mass, peritonitis, sigmoid perforation, descending sigmoid colon necrosis, ileocolic intussusception, and iatrogenic rectal laceration. Of the non-malignancy patients, 14 had ASA II status and 1 had ASA III, indicating a higher prevalence of ASA II/III among cancer patients compared to non-malignancy etiologies.

In the ileostomy cohort, 48 out of 70 patients had malignancies, with 8 classified as ASA I and 40 as ASA II. None of the cancer patients receiving ileostomy exhibited ASA III, suggesting a milder clinical presentation. Non-malignancy ileostomy patients presented with conditions such as rectovesical fistula, ileal perforation peritonitis, sigmoid perforation peritonitis, cecal perforation peritonitis, abscess, trauma, diverticulum perforation, appendicitis, Fournier gangrene, and obstructive ileus. Among these patients, 5 had ASA II status and 17 had ASA I. Similarly, cancer patients showed a higher prevalence of ASA II compared to non-malignancy etiologies.

Ostomy procedures were predominantly elective, with stoma creation taking ≤4 hr, and most patients had hospital stays of ≤7 d. Moreover, over 76.4% of patients experienced no complications. Among those who did, 17 patients were classified as CD II and 16 as CD III. In a study by Krebs (2019), out of 218 stoma patients, 75.2% had no complications, while the remaining cases were classified as CD I (20 patients), CD II (18 patients), CD III (9 patients), CD IV (3 patients), and CD V (1 patient).[6]

Meanwhile, post-ostomy creation complications in the study by Nassif *et al.*[8] occurred in only 35.6% of patients, with an average hospital stay duration of 25.9 d.[8] The average duration for stoma closure overall is 270±193 d, with a median of 236 d. In the study by Nassif *et al.*,[8] the median time for stoma closure was 222.5 d (interquartile range, IQR, 122-228).

Analysis of significant variables of colostomy group

Bivariate analysis revealed associations between BMI, underlying disease, complications, and stoma closure duration ($p < 0.05$). Variables that meet $p<0.25$ will undergo multivariate analysis. BMI and hemoglobin levels associated with closure duration ($p = 0.010$ and 0.044, respectively) in multivariate analysis.

Subgroup analysis of cancer patients in the study by Nassif *et al.*[8] revealed that overall complications post-primary surgery (OR:127.28; 95%CI:17.06 - 237.50; $p = 0.0254$), and receiving adjuvant therapy (OR:173.59; 95%CI:48.56 - 298.62; $p = 0.0084$) were significant predictors for longer closure time in multivariate analysis. In a study conducted by Lertsithichai *et al.*,[17] complications were compared between patients undergoing colostomy and ileostomy. The results indicated that temporary colostomy significantly increased the likelihood of stoma complications in colorectal cancer patients undergoing elective resection and also led to more infectious and wound complications. Conversely, temporary ileostomy tended to result in more post-closure surgical complications.[17] In this study, the most common complications were relaparotomy, adhesions, and colon resection in 10 patients, followed by septic shock in 6 patients and depression in 1 patient.

Obesity in patients correlates with a higher incidence of wound infections, increased risk of wound dehiscence,

and anastomotic leakage. Moreover, obese patients are more prone to stoma-related complications such as parastomal hernias, mucosal separation, stoma retraction, and stoma prolapse.[18] Studies by Saito *et al.*[19] have linked BMI with prolonged stoma closure intervals, which associated with postoperative complications. Higher BMI values were identified as significant risk factors for postoperative complications, with a BMI of 24 kg/m^2 serving as a threshold, above which the incidence of complications significantly rises. Obesity is linked to increased systemic inflammation, disrupting wound healing processes and extending the time needed for stoma closure.[19]

Similarly, low hemoglobin levels or anemia are associated with post-stoma creation complications, particularly anastomotic leakage, which can heighten the risk of ischemia. Ischemia has been described as a risk factor for leakage; therefore, adequate blood flow is prioritized during anastomosis creation. Currently, this assessment relies on subjective evaluations based on tissue characteristics and blood loss, without considering factors such as hemoglobin concentration or tissue oxygenation. Although this relationship is not fully elucidated, intraoperative blood loss can be considered a surrogate measure for decreased hemoglobin levels.[20]

Analysis of significant variables ileostomy group

In the ileostomy group, the median time for stoma closure interval is 176 d (IQR 101-289). However, several surgical experts concur in the literature that ileostomy closure should ideally occur no sooner than 60 to 90 d post-preserving sphincter proctectomy. This timeframe represents an optimal period where patients have recovered from the primary surgery, intra-abdominal adhesions are more manageable, and stoma inflammation and edema have subsided, making it the "sweet spot" for closure.[21] But time extensions can occur due to several factors.

The results indicate that underlying disease, cancer stage, chemotherapy status, complications, and type of surgery are associated with the duration of stoma closure. Similar findings were observed in a study by Chau *et al.*[22] involving rectal cancer patients, where chemotherapy administration correlated with the duration of stoma closure (p=0.0005). In Barenboim *et al.*[23] factors associated with stoma non-closure in multivariate analysis included pathological stage 3 [13 (52%) vs 51 (24.2%); p = 0.032], disease recurrence [14 (56%) vs 40 (18.9%); p = 0.048], hospital stay > 10 d (p = 0.032), and anastomotic leakage with Clavien-Dindo score > 2 or reoperation [6 (24%) vs 13 (6.1%); p = 0.019].[23]

Underlying diseases and chemotherapy may weaken the immune system and slow tissue regeneration, delaying wound healing. The mechanisms governing wound healing can promote the growth of malignant cells, while chronic inflammation is associated with malignant transformation and tumor development. The tumor microenvironment resembles chronic wounds, where infiltrating immune cells stimulate tumor growth and invasion. Environmental stimuli, like hypoxia and DNA damage, prompt tumor cells to release chemokines, recruiting pro-tumor inflammatory cells and fostering a pro-tumor immune response.[24] Chemotherapy often causes skin toxicity like rashes and dryness due to its effects on cell metabolism and division. It also inhibits inflammation and angiogenesis, slowing wound healing by reducing collagen production and impairing the immune system, increasing infection risks.[25]

In multivariate analysis, only the complication variable was associated with duration of stoma closure (p = 0.008).

A study in Sweden explored ileostomy reversal timing post-proctectomy, citing reasons for delay. Of 106 patients, 79% underwent reversal, with 19% within 4 mo post-low anterior resection, while 81% were delayed beyond 4 mo. Delay reasons included low medical priority (58%), non-surgical complications (20%), symptomatic anastomotic leaks (12%), and postoperative chemotherapy (10%). Risk factors for permanent ileostomy diversion were stage IV cancer ($p < 0.001$) and symptomatic anastomotic leaks ($p < 0.001$).[26] Another study evaluated 27 patients, with 9 (33%) experiencing postoperative complications and delayed closure, while 18 (66%) underwent early loop ileostomy closure at an average of 11 d (7-21 d) after the initial procedure.[27] This aligns with our findings, where complications such as septic shock, stoma prolapse, anastomotic leaks, cecal leaks, and wound dehiscence were observed.

Common early complications post-stoma creation includes leakage and skin irritation, high output leading to fluid and electrolyte imbalances, or stoma necrosis; advanced complications encompass parastomal hernia, stoma prolapse, and stoma stenosis. These complications may arise due to surgical factors or patient-related factors.[12]

Redirecting fecal flow alters gut microbiota, causing mucosal inflammation, muscle atrophy, and colonic inflammation, leading to bacteremia and postoperative ileus. Despite restoration attempts, hidden histological changes and altered enteric nervous system function may persist longer than anticipated, maintaining inflammation and bowel dysfunction for years post-surgery.[28] Research conducted by Whitney *et al.*[29] revealed thirty-seven cases of small bowel obstruction or partial small bowel obstruction (SBO or pSBO, 9.79%), 5 cases of anastomotic leakage in ileoileostomy (7.4%), and 4 cases of pouch leakage (5.9%). Eight patients experienced systemic inflammatory response syndrome (SIRS) within the first 5 d post-operation without an identified intra-abdominal source following extensive examination.[29]

Surgical complications include wound infections, fecal fistula, anastomotic dehiscence, small bowel obstruction, and incisional (peristomal) hernia. Evaluating prevention and management strategies for these complications is best done through randomized controlled clinical trials. Eighteen such trials have explored various approaches to stoma construction, typically involving randomizing patients to receive either temporary loop colostomy or loop ileostomy and monitoring for complications. The analysis reveals that the only significant difference between the two stoma sites is the increased risk of stoma prolapse associated with loop colostomy.[30]i However, this study did not specifically analyze the type of surgery, as well as stoma placement.

Limitation and future directions

This study has limitations as its retrospective design using medical records may yield incomplete or insufficiently detailed data, affecting analysis outcomes. There's a risk of selection bias as medical records might not fully represent the general population, limiting findings' generalizability. Small sample size compromises statistical power and generalization, while varied clinical conditions and backgrounds may impact results. Clinical variables like BMI, hemoglobin levels, and complications may suffer from measurement errors. Unidentified confounding factors and complex interactions between variables may affect the results. Additionally, changing clinical practices and technology might affect data collected over time.

For future studies, a scoring system based on multivariate analysis can be developed by conducting a study with a larger sample size that will be more

representative of the population. This scoring can help predict the right time to close the stoma based on the predictor factors found in patients. In addition, a prospective cohort study design can further strengthen the relationship between predictive factors and the patient stoma closure interval. Studies on the pathophysiological mechanisms of stoma closure from each predictive factor can also increase our knowledge about stoma closure intervals.

CONCLUSION

The findings indicate that in the colostomy group, BMI, underlying disease, and complications associated with stoma closure duration. Multivariate analysis revealed that both BMI and hemoglobin levels are independently associated with closure duration. Specifically, increased BMI, advanced disease stage, chemotherapy use, complications, and lower hemoglobin levels predicted a longer duration until stoma closure. Conversely, chemotherapy appeared to reduce the risk of prolonged stoma closure in this group.

In the ileostomy group, underlying disease, cancer stage, chemotherapy status, complications, and surgery type were associated with closure duration . Multivariate analysis showed that complications were independently associated with closure duration. Furthermore, advancing disease stage, chemotherapy, longer surgery duration, and lower albumin levels seemed to increase the risk of prolonged closure in the ileostomy group, while non-malignant diseases and elective surgery appeared to reduce this risk.

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