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Indications for Stoma Creation and Early Outcome Predictors of Stoma Closure at Universtiy of Dodoma Teaching Hospitals

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ABSTRACT

Background: *In advanced and developing countries stomas are commonly applied to clients , which can either be colostomy or ileostomy. These stomas are associated with post operative complications which might be the causal factors for the morbidity and mortality to our surgical patients. This study focus and analyse the indications of stoma creation, it also explores early outcome predictors of stoma closure.*

Objective: *The aim of this study was to determine the indications for stoma creation and early outcome predictors of stoma closure.*

Methodology: *The study was prospective, descriptive cross-sectional done at BMH, DRRH and IRRH from June 2021 to August 2022. The structured questionnaire was used as a tool for data collection. The information was obtained from patients, case notes or register book. Convenient sampling technique was used to select clients. Clavien-Dindo tool was used for grading severity of post-operative complications, chi-square, binary and multivariate logistic regression were used to establish association between predictor and outcome variables. SPSS was used for analysis.*

Results: *A total of 194 subjects were enrolled in this study. There were 140 males (72.2%) and 54 females (27.8%) with male to female ratio of 3:1. Colostomy was the leading type of stoma created at 133 (68.6%) followed by ileostomy 61 (31.4%). Commonest indications for colostomy were sigmoid volvulus 75 (56.4%) and colo-rectal carcinoma 43 (32.3%). Ileostomy was commonly indicated in enteric perforation 24 (39.4%) and ileal trauma 20 (32.8%).*

Overall post-stoma closure complications were noted in 78 (40.2%), colostomy contributed by 60 (30.9%) and ileostomy at 18 (9.3%). The noted post-operative complications were deep & organ/space SSI 52 (26.8%), AL & ECF 21 (10.8%) and IO 05 (2.6%). Clavien-Dindo tool showed 78 (40.2%) unfavorable and 08 (4.1%) favorable outcomes.

Binary logistic regression showed predictors of complications to be blood transfusion ($p<0.001$), hypo-albuminemia ($p<0.001$) and colostomy closure ($p=0.041$). Multivariate logistic regression showed hypo-albuminemia ($p=0.002$) a significant early outcome predictor of stoma closure.

Conclusion: *Hypo-albuminemia was shown to be important prognostic indicator for complications following stoma closure. The stomas were commonly indicated in sigmoid volvulus and enteric ileal perforation, and predominant post stoma closure complications were surgical site infection (SSI).*

Clavien-Dindo scoring system was also shown to be effective for grading severity of post-operative complications.

Keywords
Clavien-Dindo, Hypo-albuminemia, Surgical site infection, Enterocutaneous fistula (ECF), Anastomotic leakage (AL).

Abbreviations
AL: Anastomotic Leak, BMC: Bugando Medical Centre, BMH: Benjamin Mkapa Hospital, CDC: Clavien-Dindo Classification, DRRH: Dodoma Regional Hospital, DSM: Dar es salaam, ECF: Entero-Cutaneous Fistula, GA: General anesthesia, ICU: Intensive Care Unit, IO: Intestinal Obstruction, IRRH: Iringa Regional Referral Hospital, LA: Local anesthesia, RA: Regional anesthesia, RSA: Republic of South Africa, UDOM: University of Dodoma, UK: United Kingdom, USA: United States of America, WHO: World Health Organization.

Background
Stoma refers to a surgically created fistula involving loop of an intestine and abdominal wall aiming at either gastro-intestinal decompression or de-functioning, anatomically categorized into ileostomy and colostomy [1,2].

Stoma creation is a commonly performed procedure with a total reported global annual incidence rate of 10%. In the USA, annual incidence rates of stoma creation were found to be (5.5%) for ileostomy and (4.6%) for colostomy [3,4]. In the UK, stoma annual incidence rates were found to be (13.5%) while in Germany it was reported to be (6.4%) [5-7]. In Africa, data regarding stoma creation is scarce and fragmented, however, annual incidence for stoma creation was found to be (15.5%) in Ethiopia [8].

The commonest indication for ileostomy and colostomy were found to be colo-rectal cancer in the USA (2.8%-31%) [9]. In India and Pakistan, commonest indication for ileostomy were found to be enteric perforation (27%-44%) followed by trauma to ileum (27%-36.0%) [10,11]. Published studies in Africa showed rectal tumour was one of common indication for ileostomy (51%) in RSA [12]. Engida et al. [13] in Ethiopia reported common indications for colostomy to be gangrenous sigmoid volvulus (46.5%), followed by colo-rectal cancer (21%) and penetrating abdominal injury (11.4%). Moreover, Massenga et al. [14] in Tanzania reported common indications for both ileostomy and colostomy to be bowel perforation (31.8%), followed by mechanical bowel obstruction (22.7%), anal & penetrating abdominal injuries (15.9%) and neoplastic pathology (11.4%).

Stoma is regarded as a two-edged sword, its creation saves life yet its presence is associated with multitude of social-economic and psychological challenges. In the USA and Europe, it was found that, (21%-53%) of patients living with stoma face negative effects on their physical, financial and psychological well-being (anxiety & depression), experience diminished role function and social stigmatization leading to inability to cope with new life style [15-17]. In Africa, similar socio-economic and psychological challenges were reported in Uganda and Ethiopia [18,19].

Stoma closure/reversal is a surgical restoration of intestinal continuity in order to allow the passage of feces through the anus. Usually performed following corrections of the underlying primary pathology when the bowel loops are healthy without distal obstruction [20,21]. The procedure carries with it significant morbidity of (2.1-64.8%) globally [22,23]. Moreover, the morbidity was estimated to be (4.3%-40%) and (6.7%-54%) for ileostomy closure and colostomy closure respectively [24,25]. Studies conducted in Africa, reported the morbidity of ileostomy closure to be (47.5%) in RSA and (63.4%) for both ileostomy & colostomy in Tanzania [12,14].

Globally, common complications following ileostomy reversal were found to be mechanical IO (1.4-32.6%), SSI (2%-41.6%) and ECF/AL (1.7-16.6%) [26,27] and for colostomy reversal were found to be SSI (15%-40%) and ECF/AL (1.5%-21%) [28,29]. Studies conducted in Africa reported complications following ileostomy closure to be mechanical IO (14%) and ECF (6%) in RSA [12], in East Africa, complications following colostomy closure were reported to be IO (13.4%) and ECF (3.5%) in Kenya and in Tanzania common complications were reported to be SSI (50%) and ECF (33%) [14,20].

Clavien-Dindo scoring tool is utilized in the USA and Europe for the grading the severity of complications following stoma closure and thus its applicability has always been paramount in the grading of the severity of outcomes [26,30,31]. In Africa, very few studies have made use of this tool in the arena of stoma closure, a single study on ileostomy closure conducted in RSA had utilized its application [12].

Studies conducted in the USA and Europe reported underlying predictors for the complications following stoma closure to be advanced age of patients (> 50 years), junior skills of the operating surgeon, low serum albumin, [26,31], anemia, blood transfusion, increased duration to stoma reversal (> 12 weeks) [32,33]. Sheikh, [20] reported predictors of complications following colostomy closure to be colonic obstruction and sigmoid colostomy in Kenya while junior skill of the operating surgeon was the reported independent predictor in Tanzania [14].

This study focused on determining the indications for stoma creation, early outcome predictors of stoma closure and grading of complications following stoma closure using Clavien-Dindo scoring tool on both ileum and colon.

Objectives
Broad Objective
To determine indications for stoma creation and early outcomes predictors of stoma closure at University of Dodoma teaching Hospitals from June 2021 to August 2022.

Specific Objectives
i. To determine indications for stoma creation at University of Dodoma teaching Hospitals from June 2021 to August 2022.
ii. To determine early surgical outcome of stoma closure and grade complications by using Clavien-Dindo scoring tool at University of Dodoma teaching Hospitals from June 2021 to August 2022.

iii. To determine early outcome predictors of stoma closure at University of Dodoma teaching Hospitals from June 2021 to August 2022.

Methodology

Study Design

A prospective cross-sectional study where study subjects were followed and post-operative outcomes were recorded within the 1st week, then on the 2nd and 4th week.

Study Area

This study was conducted at Dodoma Regional Referral hospital (DRRH) and Benjamin Mkapa Hospital (BMH) both located in Dodoma region and Iringa Regional Referral Hospital (IRRH) located in Iringa region. These hospitals conduct both outpatient and inpatient surgical services, perform minor and major surgical procedures and serve as teaching hospitals for undergraduate and post-graduate students.

Study Population

Adult patients (>17years) admitted to surgical departments at University of Dodoma Affiliated teaching Hospitals (BMH, DRRH and IRRH) from June 2021 to August 2022.

Study Sample

Adult patients (>17years) with stoma in-situ admitted at University of Dodoma Affiliated teaching Hospitals and underwent stoma closure from June 2021 to August 2022.

Study Duration

15 months, from June 2021 to August 2022

Inclusion Criteria

- All patients who underwent secondary stoma closure
- All patients who underwent subsequent stoma closure following failure of the first attempt.

Exclusion Criteria

- Patients having both ileostomy and colostomy in situ (one closed while one left open)
- Patients with stoma closure and open abdomen.
- Patients with stoma closure with delayed primary abdominal closure.

Sample Size Estimation

By using Kish-Leslie formula.

Sample size $= Z.\ P\ (1\text{-}P)/d2$

$$= \frac{1.96 * 0.146 * (1 - 0.146)}{(0.05)2}$$

= 97 subjects.

Z is statistic for a level of confidence. (At 5%, $P < 0.05$), Z value is 1.96.

P is prevalence of post-operative complications based on a previous study conducted at BMC in Tanzania "Indications for and complications of intestinal stomas in the children and adults at a tertiary care hospital in a resource- limited setting: a Tanzanian experience" [14].

Prevalence of complications for adults (> 17 years) was 14.6%.

d is absolute error of precision, (considered 0.05).

Sampling Method

Convenient sampling was applied where all patients who underwent secondary stoma closure from June 2021 to August 2022 and met inclusion criteria were included.

Interview

Patient's information was extracted using standardized questionnaire.

Measurements

This study used some laboratory investigations to assess underlying predictors for complications (SSI, AL/ECF & IO); serum albumin, Full blood Picture and Blood grouping & cross-match.

Data Collection Tools

A standardized questionnaire was used to collect patient's demographics details, laboratory blood investigations results, clinical and surgical information of the index operation &surgical details of the current operation including post-operative details. Post-operatively, patients were followed and complications recorded within the 1st week then on 2nd and 4th week.

Clavien_Dindo classification tool was utilized post-operatively to assess the modality of management (conservatively versus surgical) offered for the complications that occurred.

Procedure

Blood samples for investigations (CBC, grouping & cross-match, serum albumin) were collected pre-operatively and post-operatively and results followed promptly and recorded. Prophylactic antibiotics were given 30 minutes prior to cutting time, commonly used were ceftriaxone and intravenous metronidazole.

Data Processing and Analysis

Microsoft excel was used for data entry and cleaning. Analysis of data was done using Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive analysis was utilized to analyze for frequency and percentages of the variables. Cross tabulation between management modality given and the severity of complications was used for the third objective.

Significance of association between the dependent (outcome) and in- dependent (predictor) variables was tested by using Chi-square ($\chi 2$) test. Statistical significance was considered as $p < 0.05$. Variables which were statistically significant in binary logistic regression were subjected to multivariate logistic regression for the final determination of independent predictors.

Ethical Clearance

Ethical clearance was sought and granted from the UDOM senate research and publication committee. Permission to conduct data collection was sought and granted from the administration of the respective hospitals where the study was conducted.

Ethical Issues

The researcher obtained informed consent from all patients themselves. While drawing blood for investigations, proper techniques to avoid traumatizing patients unnecessarily were used. All laboratory and histo-pathological results were filled in the questionnaire promptly. All questionnaires were coded in numbers to ensure confidentiality. Back up data was used to prevent breach information and to avoid data loss.

Research Findings

Background of respondents

A total of 194 participants, comprising of (72.2%) men, participated in the study, as shown in Table 1. The male to female ratio was 2.6:1. Participants in the study ranged in age from 18 to 77, with a median age of 46. Age group (34-51) years old occupied the majority (49.5%). IRRH performed most of the stoma reversal (39.2%).

Table 1: Demographic characteristics of study participants who underwent stoma closure.

Variable	Category	Frequency (n=194)	Percentage (%)
Age group	18-34 years	38	19.6
	35-51 years	96	49.5
	> 51 years	60	30.9
	Median =46 (18-77)		
Sex	Male	140	72.2
	Female	54	27.8
Hospital attended	DRRH	70	36.1
	IRRH	76	39.2
	BMH	48	24.7

Colostomy made up the majority of stomas, 133 (68.6%), as shown in table 2. Mean hemoglobin was 11.4 and the ratio of non-anemic to anemic was 4:1. Only 55 (28.4%) of study participants were found to have low serum albumin and the mean serum albumin was 3.49 (+/-0.4). Colo-rectal malignancy was diagnosed in 22.2% of study patients. Mean duration from stoma creation to reversal was 10.5 weeks.

Table 2: Clinical and surgical characteristics of study participants who underwent stoma closure.

Variable	Category	Frequency (n=194)	Percentage (%)
Type of stoma	Colostomy	133	68.6
	Ileostomy	61	31.4
Hemoglobin level	Normal (11g/dl and above)	155	79.9
	Low (< 11 g/dl)	39	20.1
	Mean	11.4+-0.6	
Serum Albumin level	Normal (>3.5g/dl and above)	139	71.6
	Low (<3.5g/dl)	55	28.4
	Mean	3.49+-0.4	
Duration from index surgery	< 8 weeks	70	36.1
	8 weeks and above	124	63.9
Malignancy status	Positive	43	22.2
	Negative	151	77.8

Descriptive Statistics

Indications for stoma creation

Indications for ileostomy creation, as shown in figure 1 below, were enteric ileal perforation 24 (39.3%), traumatic ilealinjury (penetrating) 20 (32.8%), gangrenous ileal obstruction 11 (18.0%), and ilealanastomotic leakage (AL) 06 (9.8%).

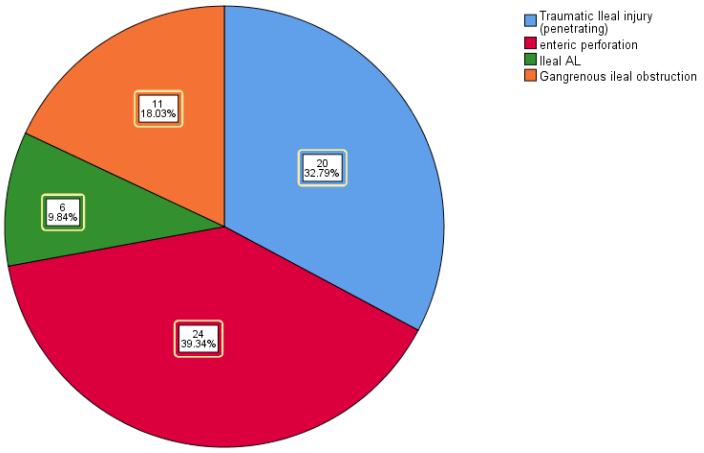

Figure 1: Indication for ileostomy creation.

Figure 2 shows that sigmoid volvulus was the leading cause of colostomy creation with a 56.4% rate, followed by colo-rectal cancer with a 32.3% rate, colonic AL with a 9.8% rate, traumatic colonic injury (penetrating) with a 3.0% rate, and anal fistula and abscess with a 1.5% rate.

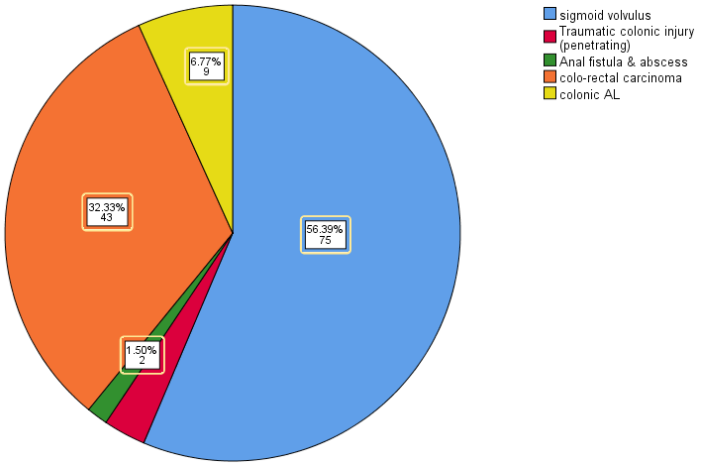

Figure 2: Indications for colostomy creation.

Early Outcome of Stoma Closure and Severity of Outcome

The overall post-operative outcome were (40.2%), as shown in table 3 ileostomy contributed 18 and colostomy contributed 60. Overall SSI (deep/organ & space) was the most common complication in both ileostomy 10 (16.4%) and colostomy 42 (31.6%). IO was the least common complication in both ileostomy 03 (4.9%) and colostomy 02 (1.5%).

Table 3: Early outcome following stoma reversal.

Complication	Ileum (n=61)	Colon (n=133)	Total (n=194)
Deep/organ& space SSI	10 (16.4)	42 (31.6)	52 (26.8)
Anastomotic leak (AL) & Enterocutaneous fistula (ECF)	05 (8.2)	16 (12.0)	21 (10.8)
Intestinal obstruction (IO)	03 (4.9)	02 (1.5)	05 (2.6)

Clavien-Dindo Grading of Early Outcome Following Stoma Closure

Clavien-Dindo classification, as shown in table 4, indicates favorable to unfavorable outcome ratio of 1:10. Only 08 (4.1%) patients developed superficial SSI only requiring conservative management. 76 (39.2%) patients with (IO, AL/ECF and deep & space SSI) underwent surgical management under general anesthesia. 2 (1.0%) patients died, each one from mechanical IO and ECF.

Table 4: Clavien-Dindo grading of early outcome following stoma reversal.

Severity	Category	Class	N (%)	Management
Favorable	Superficial SSI	I	08 (4.1)	Conservative
	Total (n1)		**08 (4.1)**	
	Deep & organ/space SSI	IIIb	52 (26.8)	Surgical (GA)
	AL & ECF	IIIb	20 (10.3)	Surgical (GA)
	IO	IIIb	04 (2.1)	Surgical (GA)
Unfavorable	Death	V	02 (1.0)	
	Total (n2)		**78 (40.2)**	
	(n1+n2)		**86 (44.3)**	

Inferential Statistics

Chi-square test

The following predictor variables exhibited a significant association with the outcome variable, as shown in table 5 of (chi-square) X^2. Serum albumin $(X^2=14.642,\ p=0.002)$, blood transfusion $(X^2=15.653,\ p<0.001)$, bowel segment $(X^2=4.236,\ p=0.042)$.

Table 5: Chi-square test showing association between predictor variables and outcome variables following stoma closure.

Variable			Outcome			
		N	Good (N/%)	Poor (N/%)	X^2	p-value
Age group					3.668	0.168
	18-34 years	36	27 (71.1)	11 (29.9)		
	35-51 years	98	58 (60.4)	38 (39.6)		
	> 51 years	60	31 (51.7)	29 (48.3)		
Sex					0.559	0.514
	Male	140	86 (61.4)	54 (38.6)		
	Female	54	30 (55.6)	24 (44.4)		
Duration to stoma reversal					0.462	0.810
	< 8 weeks	70	42 (60)	28 (40)		
	> 8 weeks and above	124	74 (59.7)	50 (40.3)		
Hemoglobin class					0.718	0.466
	Normal	155	95 (61.3)	60 (38.7)		
	Anemia	39	21 (53.8)	18 (46.2)		
Blood transfusion					15.653	**<0.001**
	Done	86	38 (44.2)	48 (55.8)		
	Not done	103	78 (72.2)	30 (27.8)		
Level of surgeon					0.041	0.879
	Resident	68	40 (58.8)	28 (41.2)		
	Surgeon	126	76 (60.3)	50 (39.7)		
Prophylactic antibiotic use					0.221	0.652
	Given	159	100 62.9)	59 (37.1)		
	Not given	35	16 (45.7)	19 (54.3)		
Non-malignant etiology for stoma creation	Peritonitis	74	43 (58.1)	31 (41.9)	4.032	0.262
	Bowel injury	75	41 (54.7)	34 (45.3)		
	Perineal pathology	02	02 (100)	00 (0)		
Malignancy status					0.063	0.861
	Present	43	25 (58.1)	18 (41.9)		
	Absent	151	91 (60.3)	60 (39.7)		
Bowel segment utilized					4.236	**0.042**
	Ileostomy	61	43 (70.5)	18 (29.5)		
	Colostomy	133	73 (54.9)	60 (45.1)		
Serum albumin					14.642	**0.002**
	Normal	139	123 (82.7)	16 (17.3)		
	Low	55	26 (47.3)	29 (52.7)		

Table 6: Binary logistic regression and multivariate logistic regression showing strength and direction of association between predictor variables and outcome variables following stoma reversal.

Variable/value	N	COR [95% CL]	p-value	AOR [95% CL]	p-value
Age group					
18-34 years	36	Ref			
35-51 years	98	1.142 [0.588-2.215]	0.695		
> 51 years	60	1.545 [0.668-3.576]	0.309		
Sex					
Male	140	Ref			
Female	54	1.147 [0.606-2.168]	0.674		
Duration to stoma reversal					
> 8 weeks	124	Ref			
< 8 weeks and above	70	1.014 [0.557-1.843]	0.965		
Blood transfusion					
Not given	103	Ref			
Given	86	3.284 [1.805-5.976]	**<0.001**	**2.176 [1.876-5.368]**	**0.630**
Level of surgeon					
Resident	68	1.064 [0.584-1.940]	0.840		
Surgeon	126	Ref			
Non-malignant etiology for stoma creation					
Peritonitis	74	1.664 [0.749-3.695]	0.211		
Bowel injury	75	1.914 [0.865-4.233]	0.109		
Perineal pathology	02	Ref			
Malignancy status					
Positive	43	1.092 [0.549-2.173]	0.802		
Negative	151	Ref			
Bowel segment involved					
Ileostomy	61	Ref [ ]			
Colostomy	133	1.963 [1.027-3.752]	**0.041**	**2.593[1.288-5.223]**	**0.087**
Serum albumin					
Normal	139	Ref			
Low	55	5.329 [2.183-9.00]	**< 0.001**	3.885[1.067-7.301]	**0.002**
Antibiotic prophylaxis					
Given	159	Ref			
Not given	35	1.497 [0.237-1.040]	0.063		
Hemoglobin level					
Normal	155	Ref			
Anemia	39	1.357 [0.669-2.754]	0.398		

Regression Analysis

Binary logistic regression showed serum albumin *(p < 0.001),* blood transfusion *(p < 0.001)* and colostomy reversal *(p=0.041)* to be statistically significant predictor variables for post-operative outcome as shown in table 6 below. Multivariate logistic regression showed only serum albumin *(p= 0.002)* to be a statistically significant predictor variable.

Discussion

Background of the participants

In this study, the predominant age group was (35 to 51) years (50%), the median age was 46 years and male being predominant to female with ratio of (3:1). Our ratio results were similar to those of Mehboob et al., [11] in Pakistan (3:1), and S. Khan et al., [34] in Pakistan (3:1) but were contrary to Massenga et al., [14] in Tanzania (1:1). The reason for the difference in this study was predominance of middle and older patients (35-50) years, with exclusion of pediatric population (<17years). Adisa et al. [35] commented that male predominance was attributed by the social habit of African men being the income generating gender group hence occupationally they are relatively more exposed to road traffic accidents, relative more involvement in violent robbery, physical assaults & trauma [35]. Moreover, Cheatham et al. [36] and Makgopa et al. [37] found that African men are reported to have poor healthcare-seeking behaviors (exemplified by self-medicating at home, waiting for some period to see if the condition subsides on its own, late visitation to a healthcare facility only when the symptoms worsen which necessitates need for urgent surgery) [36,37]. Arnold et al. [38] suggested that epidemiologically in Sub-Saharan Africa, males are more affected by colon malignancy as compared to women [38].

Adisa et al. [35] suggested the (35-51) year age group being a socially active age-group for income generation with resultant increased risk of occupational & physical assaults and road traffic accidents. Moreover, busy working schedule with likelihood to delayed visitation to health facility for timely treatment [35]. Statistically, the ratio of colostomy to ileostomy was 2:1. The tendency to form colostomy is greater than ileostomy. Migdanis et al. [39] suggested that this is attributed by the reduced need for

nutritional support and reduced risk of nutritional deficiencies in the colostomy group as compared to ileostomy [39]. Moreover, Ma et al. [40] suggested that microbiotadysbiosis as well as higher number and wide variety of anaerobic bacteria present in the colon produce microbial-derived collagenases which lead to tissue destruction and poor anastomotic healing, a situation uncommon to ileum. Therefore, this attributes to higher rate of colostomy compared to ileostomy.

Indications for Stoma creation

Analysis showed indications for ileostomy creation to be enteric perforation (39%), followed by penetrating & blunt ileal trauma (33%), then, strangulated hernias (SBO) (18.0%) and ileal AL (10%). Regarding enteric perforation, our findings were similar to findings by Q. A. Ahmad et al. [41], in Pakistan (30%) and Massenga et al. [14] in Tanzania (32%). Ngogo et al. [42] suggested high prevalence (16.5%) of enteric infections in Tanzania is attributed by poor food handling, consumption of contaminated water from wells and rivers, coupled with a habit of defecating in the bush and in the rivers leading to fecal-oral transmission of etiological micro-organisms a common habit in many parts of Tanzania, the high prevalence of infections contributes to higher chances of developing enteric bowel perforation.

Regarding penetrating & blunt ileal trauma, our findings (33%) were similar to A. Khan et al., [10] in Pakistan (36%). Regarding penetrating & blunt colonic injury, our findings (2%) were similar to Horesh et al., [23] in Germany (2%) and by Engida et al., [13] in Ethiopia (12%). Both ileal and colon penetrating and blunt injuries share similar risk factors mainly being road traffic accidents, physical assaults and violent robbery. Moshiro et al. [43] suggested that abdominal injuries with resultant bowel injuries (ileum & colon) are highly attributed by increasing incidence of road traffic accidents, physical assaults and violent robbery at a fast rate due to increase in urbanization, motorization as well as criminal activities. Moreover, Chalya et al. [44] and East et al. commented that road traffic accidents contributed to (28%-65%) followed by physical assaults, and falls leading to 3% of blunt bowel injuries and 3% of penetrating bowel injures (stabbing or gunshots).

With regard togangrenous small bowel obstruction, we had findings (18%) contrary to those of Nafis Faizi, Shahwar Kazmi [45] in India (4%) and Z. Ahmad et al. [46] in India (7%). The reason behind the observed difference could be multifactorial. Cheatham et al. [36] and Makgopa et al. [37] suggested first reason could be because of delayed hospital visitation due to poor road infrastructure, second being poor knowledge on the complications of strangulated hernia, third being self-medicating at home until when the condition gets worse, which further increases chances for bowel strangulation with subsequent stoma formation. Moreover, there is a relatively high incidence of symptomatic and strangulated hernia in Tanzania with an annual incidence of symptomatic hernias in adults being (0.163%). Beard et al. [47] suggested increased tendency to heavy lifting and increased intra-abdominal pressure lead to the high incidence of symptomatic hernia with subsequent strangulation and stoma formation. Moreover, Chalya et al., [44] suggested occupational risk factors for inguinal hernia strangulation to include increased tendency to heavy lifting activities which is one among major income generating jobs among Tanzanian men of middle and low income. Moreover, Kibret et al. [48] and Ashindoitiang et al. [49] suggested prolonged heavy lifting and chronic constipation being two among common etiological risk factors for symptomatic hernia and subsequent strangulation.

Moreover, prolonged post-operative small bowel obstruction (SBO) could lead to bowel strangulation with subsequent gangrenous bowel changes increasing chances for stoma formation, the underlying reasons for prolongation being delayed hospital visitation, self-medicating at home until when the condition gets worse as suggested by Cheatham et al. [36] and Makgopa et al. [37]. Moreover, Massenga et al. [14] reported annual incidence of laparotomy in Tanzania to stands at (5.5%) with significant number of those patients reporting post-operative small bowel obstruction as one among common complications. Tabibian et al. [50] and Herrick & Wilm [51] reported risk factors for post-operative small bowel obstruction (SBO) to include peritoneal adhesions secondary to previous abdominal surgeries (laparotomy) leading to excessive fibrin deposition.

Furthermore, regarding ilealanastomotic leak (AL) (10%) our findings were similar to those of Z. Ahmad et al., [46] in India (4%), Chaudhary et al., in India (7%). and Massenga et al., [14] in Tanzania (11%). Regarding colonic anastomotic leak (AL), our findings (7.0%) were similar to those of Whitney et al., [52] in the USA (15%) and Massenga et al., [14] in Tanzania (11.0%) and Azodo & Omuemu [53] in Nigeria (15%). Both ileal and colon anastomotic leaks share similar risk factors most common being poor nutrition due to low serum albumin. Issangya et al. [54] suggested ileal and colonic anastomotic leak (AL) could be attributed to poor nutrition status of the study participants (low albumin level) leading to poor collagen synthesis and functioning resulting into delayed wound healing and hence increased chances of poor wound healing and anastomotic leaks.

Indications for colostomy creation in this study were sigmoid volvulus (56%) followed by colo-rectal carcinoma (30%), colonic AL (7.0%), penetrating colonic injury (2.0%), peri-anal fistula & abscess (2%). For sigmoid volvulus, we had findings similar to Bekele et al., (2009) in Ethiopia (50%), however, higher than findings by Sheikh, [20] in Kenya (33%). The reason for the difference could be due to variations in the type of diet that participants consumed in the particular study region. Akinkuotu et al. [55], Jumbi & Kuremu [56] and Surriah et al. [57] suggested sigmoid volvulus could be attributed by a common practice in East Africa of excessive consumption of high-fiber diet resulting into excessive loading of the sigmoid colon with subsequent increasing in intra-luminal pressure and augmenting the chances for developing colon twisting and sigmoid volvulus.

Colo-rectal carcinoma findings (30%) were similar to Daluvoy et al., [58] in the USA (30%), Engida et al., [13] in Ethiopia (20%). Constance et al. [59] suggested excessive consumption of alcohol,

which is prevalent in Tanzanian communities, could be one among risk factor for colorectal carcinoma development. Moreover, Anette et al. [60] suggested tendency of excessive consumption of red meat & animal fats and less consumption of fruits & green vegetables a habit prevalent in Tanzania could be one among the contributing factors for developing colo-rectal cancer. Furthermore, Zisman et al. [61], Kabat et al. [62] and Katalambula et al. [63] suggested excessive alcoholand red meat consumption being common attributing factors for colo-rectal carcinogenesis. Furthermore, it was postulated that reactive metabolite from alcohol (acetaldehyde) is thought to be carcinogenic, additionally, alcohol has been linked to the production of prostaglandins, lipid peroxidation, and the generation of free radical oxygen species leading to cancer progression. Red-meat carcinogenesis is augmented by exposure to heme iron from the red meat and production of heterocyclic amines and polycyclic aromatic hydrocarbons believed to have carcinogenic properties.

Analysis results showed anal &perineal pathology (fistula & abscess) findings (2%) similar to those of Daluvoy et al., [9] in USA (7%). Garg et al. [64] and Kwilas et al. [65] suggested the major attributing factor for peri-anal and perineal pathology being recurrent extensive cryptoglandular anal infection (possibly with un-diagnosed Crohn's disease). Moreover, Zheng et al. [66] and Wang et al. [67] commented that immune-suppression and excessive consumption of tobacco products being one among attributing factors for chronic anal epithelial inflammation and damage augmenting chances to infection and fistula formation. Furthermore, epidemiologically, GATS [68] suggested cigarette smoking which is common in Tanzania with overall (2.6 million) of adults currently using tobacco and its products.

Early Surgical Outcomes of Stoma Closure

The common early complications following ileostomy closure were reported to be surgical site infection (SSI-deep/organ/space, AL & ECF) (25%) and mechanical small bowel obstruction (SBO) (5%).

Regarding surgical site infection, we had findings similar to those reported by Banerjee, [12] in RSA (21%), however, lower than those reported by Memon et al., [69] in Pakistan (58%). Most of our study subjects underwent earlier stoma reversal, therefore they had relative lesser chances of developing wound infections as it has been proposed that prolonged fecal stream diversion resulted in a shift towards dysbiosis of the gut microbiota. Lee et al. [70] suggested that late (> 12 weeks) stoma reversal resulted into shift into towards dysbiosis of the gut microbiota characterized by resultant increase in harmful bacteria and a decrease in beneficial bacteria further increasing risk of developing wound sepsis.

Surgical site infection was attributed by low serum albumin which predisposes to poor collagen synthesis and functioning as well as defective ability to combat pathogenic organisms. Saha et al., [32] and Soeters et al. [71], reported serum albumin being the major player in the overall process of wound healing, its low level attributes to poor wound healing and increased chances to surgical site infections, anastomotic leaks and entero-cutaneous fistula. Moreover [70], suggested that dysbiosis of the gut microbiota especially on the defunctioning bowel segment plays a significant role in the development of surgical site infections and anastomotic leaks and fistula formation.

Regarding mechanical small bowel obstruction (SBO), we had findings similar to Mennigen et al., [72] in Germany (8%) and Mansfield et al., [73] in UK (7%). This could be attributed by smooth muscle atrophy with resultant impairment of muscle contractility and intestinal motility in the defunctioned segment leading to mechanical obstruction. Moreover, Williams et al. [74] suggested smooth muscle atrophy with resultant impairment of muscle contractility and intestinal motility in the defunctioned bowel segment predispose to mechanical bowel obstruction post-stoma reversal. Moreover, Garfinkle et al. [75] and Altmann [76] suggested that distal defunctioning leads to loss of contact with the fecal stream and pancreatico-biliary secretions which are thought to be trophic to the intestinal epithelium augmenting chances for impaired intestinal motility following stoma reversal. Furthermore, Garfinkle et al. [75] suggested that adhesions from previous surgery as well as anastomotic edema and intra-mural hematoma could be among attributing factors for development of mechanical obstruction following stoma reversal.

Complications following colostomy closure were found to be surgical site infections (SSI, AL & ECF) (44%) and large bowel obstruction (LBO) (2%). Regarding surgical site infection results were similar to findings by Shah et al., [77] in Thailand (50%), Liang et al., [78] in USA (36%) and Bekele [79], in Ethiopia (52%) . Regarding LBO, we had findings similar to Antolovic et al. [80], (5%) and Bischoff et al. [81], both in Germany (1.0%) and Bekele [8] in Ethiopia (6%). Surgical site infections (SSI/AL/ECF) were mainly attributed by bacterial dysbiosis as well bacterial-derived collagenase. Williams et al. [74] suggested dysbiosis of microbiota which predispose to increased chances of wound sepsis and alteration in the dynamics of wound healing via release of microbial-derived collagenases which disrupt normal cascade of wound healing leading to wound infection. Moreover, Saha et al. [32], and Soeters et al. [71] commented that low serum albumin leads to impairment of wound healing via reduced collagen synthesis and functioning as well as reduced ability to engulf pathogenic micro-organisms leading to wound infection and increased risk to anastomotic leak and entero-cutaneous fistula.

Clavien-Dindo classification of post-operative complications results showed significant deviation from other studies, our findings showed favorable to unfavorable outcome ratio of 1:10 Contrary findings were reported by Banerjee [12], in RSA (favorable to unfavorable ratio of 1:1.4) and Rubio-Perez [31], in Brazil (favorable to unfavorable ratio of 1:4). The difference could be due to low serum albumin leading to poor collagen function and impaired response to phagocytic functioning and wound sepsis as suggested by Saha et al. [32], and Soeters et al. [71].

Early Outcomes Predictors of Stoma Closure

Low (<3.5g/dl) serum albumin (p= 0.002) was shown to be potential predictors for post-operative complications following stoma closure. Similar findings were reported by Baik & Bae [82], in Republic of Korea (p=0.001), Christou et al. [83], in Switzerland. (p=0.002) as well as Ahmed & Sarma [84], in India (p=0.033). The paramount role of albumin in wound healing, its no wonder its low level could attribute to delayed wound healing and increased risk to surgical site infections, anastomotic leak as well as entero-cutaneous fistula. Issangya et al. [54], Majhi [85] and Soeters et al. [71] suggested hypo-albuminemia could be the main reason for poor wound healing and increased chances of wound infection through impaired transport of important nutrients (amino acids, lipids, carbohydrates, trace metals & co-factors), abnormal adhesion & modulation of collagen subunits, as well as reduced immune-modulation & inhibition of microbial invasion and colonization.

Conclusion

The common indications of colostomy were sigmoid volvulus and colo-rectal carcinoma, where as the most frequent indications of ileostomy were enteric perforation and traumatic ileal injury. Predominant post stoma closure complications were surgical site infection SSI (deep/ organ & space/AL & ECF) and mechanical intestinal obstruction(IO). Clavien-Dindo scoring system was an effective tool for grading severity of post-operative complications. Lowlevel of albumin <3.5g/dl was found to be a significant prognostic factor for complication (SSI/ECF) following stoma closure.

Declarations

Ethic approval and consents to participate.

It was obtained from the clients and ethical clearance was granted by UDOM.

Consent for publication

Ethical clearance for publication was obtained from UDOM.

Availabilty of data and materials.

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

Competing interests

Authors declare that no competing interest.

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Authors Contributions

PJM , SK and MMW participated in study designing, literature search, and data analysis. PJM participated in muniscript writing, editing, and muniscript submission

Equal Contribution

PJM and SK were the first co-authors

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