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Original Research Article

Surgical site infection after colorectal cancer surgery in Maiduguri, north-eastern Nigeria

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ABSTRACT

Background: Colorectal surgery is associated with high rates of surgical site infection (SSI). Determining risk factors for SSI may provide information on reducing complications and improving outcome. The aim of this study was to determine the incidence of SSIs in colorectal cancer patients who had colorectal surgery in our centre, and to identify the risk factors for developing SSIs in these patients.
Methods: This was a retrospective study of patients who had open colorectal surgery for colorectal cancer over a twelve-year period (2000 to 2012) at the University of Maiduguri Teaching Hospital, Nigeria. SSI included incisional SSI and organ/space SSI within thirty days of the surgery.
Results: A total of 56 patient records were analyzed. An infection rate of 33.9% was documented; all 19 infections were incisional SSIs, occurring after surgery involving the rectum and anus. The perineal incision site was involved in 63.2%, of which 75% were superficial. Wound dehiscence occurred in 26.3%. Risk factors identified to be associated with SSIs include pre-operative bowel preparation, peri-operative blood transfusion, stoma creation, tumour location and the type of operation.
Conclusions: The rate of SSIs following oncologic colorectal surgery in our centre is high at 33.9%. All the SSIs were incisional, involving surgery of the rectum and anus. The tumour site, type of operation, stoma creation, mechanical bowel preparation and blood transfusion were identified to be associated with SSIs.

Keywords: Surgical site infection, Colorectal cancer, Colorectal surgery, Risk factors

INTRODUCTION

Surgical site infection (SSI) is the most frequent nosocomial infection among surgical patients, accounting for 38% of all such infections.[1,2] It increases length of hospital stay, mortality and the cost of care. SSIs cause a substantial burden to the patient, the hospital and third-party payers, and are thus a clinical outcome indicator of fundamental importance.

In colorectal surgery, SSI is a frequent cause of morbidity, with a wide range of incidence from 3% to 30%.[3-6] This wide variation in reported rates globally is largely a function of the varying definitions that have been applied to define SSI. In addition, there has been no clear consensus on the risk factors contributing to SSI following colorectal surgery, which has hindered the progress in developing accurate and efficient systems to better measure outcomes.

The most widely-used definition for SSIs was provided by the centre for disease control (CDC) in 1992 and updated in 2003. It broadly classified SSIs into incisional SSIs and organ/space SSI.[7] Incisional SSIs were subdivided into superficial (involving skin and subcutaneous tissue), and deep (fascia and muscle layers). Organ/space SSIs include intra-abdominal and pelvic abscess and anastomotic leakage. This categorization is important because the aetiology, risk factors and clinical outcome may vary, depending on the location.

Numerous studies have been conducted to ascertain risk factors in the hope of addressing specific variables to reduce this risk, with appraisals on surgical technique, patient factors and various tools, both pharmacologic and non-pharmacologic. Our objective in this study was to determine the rate of SSI after colorectal surgery in colorectal cancer patients in our centre, and to identify potential risk factors associated with the development of SSI.

METHODS

This retrospective study spanning over a period of twelve years (July 2000 to December 2012) included patients who underwent elective and emergency colorectal surgery for colorectal cancer at the University of Maiduguri Teaching Hospital in Maiduguri, a tertiary health centre in North-Eastern Nigeria. Cases did not include those who had only examination under anasthaesia and biopsy.

The medical records of the patients were retrieved and demographic and clinical variables were recorded at the time of chart review. Data collected included age, gender, height, weight, body mass index (BMI), presence of co-existing disease (diabetes mellitus, human immunodeficiency virus HIV, hypertension), use of alcohol and tobacco. Other clinical parameters obtained included presenting symptoms and duration, physical signs, pre-operative serum albumin and packed cell volume (PCV), American Society of Anasthaesiologists' (ASA) score as determined by the anasthaesiology team, pre-operative steroid use, neo-adjuvant chemotherapy or radiotherapy, pre-operative bowel preparation, peri-operative antibiotics (including type, route, timing of administration and duration of coverage), skin preparation, type of surgery, stoma formation and bowel anastomosis, site of the tumor, tumor stage, duration of the surgery, intra-operative contamination and hypotension, and peri-operative blood transfusion. Outcome variables included development of SSI, the type of SSI, duration post-operatively upon discovery of SSI, culture yield of SSI, and potential risk factors for SSI.

All cases were done by laparotomy. Elective procedures involving the left colon routinely had a three-day combination of mechanical bowel preparation and oral laxatives and non-absorbable antibiotic preparation. Emergency procedures and most right-sided colonic resections did not have prior bowel preparation. Skin preparation involved the use of Chlorhexidine-Alcohol scrub. Parenteral antibiotics were given pre-operatively and for a variable period post-operatively, but no specific protocol was followed. All information was recorded on a data sheet, and statistical analysis was done using SPSS version 15.0.

RESULTS

A total of eighty-nine (89) patients were taken into the operating theatre with the diagnosis of, or suspected of colorectal cancer, over a period of twelve years, between 2000 and 2012, averaging a number of 7.4 cases per year. Of these, seven (7.87%) had only examination under anasthaesia (EUA) and biopsy taken, and were excluded from the study.

The remaining eighty-two (92.1%) had laparotomy, out of which fifty-six (68.3%) patients whose medical records were available for retrieval made up the study group. There were 34 males (60.7%) and 22 females (39.3%), with a male-to-female ratio of 1.5:1. The age ranged from 24 to 76 years (mean age 43.6y±13.5y).

The most common procedure performed was synchronous combined abdomino-perineal resection (SCAPR) (28/56, 50%), one of which was combined with total abdominal hysterectomy. Right colectomy was performed in ten patients (17.9%), while exploration and colostomy creation was done in four (7.1%). For ease of evaluation on the type of surgery, the patients were divided into two groups; those who had surgery on the rectum and anus (rectum group, 34, 60.7%), and those who had surgery on the colon proximal to the rectum (colon group, 22, 39.3%).

Table 1: Location of incisional surgical site infection.

	Rectum (n=34)		Colon (n=22)	
	SSI		SSI	
	Yes (n=19) n (%)	No (n=15) n (%)	Yes (n=0) n (%)	No (n=22) n (%)
Perineal op site (n=12)				
Superficial	9 (47.4%)	-	-	-
Deep	3 (15.8%)	-	-	-
Laparotomy site (n=3)				
Superficial	2 (10.4%)	-	-	-
Deep	1 (5.3%)	-	-	-
Perineal drain site	3 (15.8%)			-
Colostomy site	1 (5.3%)	-	-	-

Surgical site infection was noted in nineteen patients, giving an SSI rate of 33.9%. All of these patients who developed SSI had surgery on the rectum (SCAPR). Nineteen (55.9%) out of 34 patients who had rectal surgery had SSI, all of which were incisional (Table 1). Wound dehiscence occurred in five (26.3%) of these patients, of which three were complete wound dehiscence. The median time to diagnosis was 8.9 days. Wound swab for microscopy, culture and sensitivity was taken in 12 (66.7%) of the patients who had SSI, of which only five (27.8%) had results available on record. The main organism cultured was *E. coli* (80%), and one yielded *Proteus spp*.

In the bivariate analysis, patients were divided into those with or without SSI and compared. Patients who developed SSI were more likely to have had pre-operative bowel preparation, received blood transfusion peri-operatively, had a stoma creation, and had a tumour located in the distal colon (rectum and anal canal), and thus had surgery involving the rectum and anus. These variables had a p-value of < 0.05, as is shown in Table 2.

Table 2: Bivariate analysis.

Variables		SSI		Chi -square	p-value
N=55		Yes	No		
		n (%)	n (%)		
Age	18-34 years	7 (46.7)	8 (53.3)	4.107	0.128
	35-39 years	7 (21.9)	25 (78.1)		
	>60 years	4 (50.0)	4 (50.0)		
Sex	Male	11 (32.4)	23 (67.6)	0.006	0.94
	Female	7 (33.3)	14 (66.7)		
Pre-op Albumin					
	< 35 g/L	5 (41.7)	7 (58.3)	2.807	0.246
	35-44 g/L	6 (31.6)	13 (68.4)		
	45-50 g/L	0 (0)	3 (100)		
PCV	< 30 %	4 (36.4)	7 (58.3)	0.019	0.891
	>30 %	14 (34.1)	27 (65.9)		
ASA	I	1 (100)	0 (0)	2.505	0.286
	II	2 (33.3)	4 (66.7)		
	III	5 (62.5)	3 (37.5)		
Pre-op bowel preparation					
	Yes	17 (39.5)	26 (60.5)	4.948	0.026*
	No	1 (8.3)	11 (91.7)		
Peri-operative blood transfusion					
	None	0 (0)	11 (100)	11.266	0.010*
	<2 pints	12 (37.5)	20 (62.5)		
	3-4 pints	5 (55.6)	4 (44.4)		
	>4 pints	1 (50)	1 (50)		
Surgery group (type of surgery)					
	Rectum	18 (64.3)	10 (35.7)	24.337	0.000*
	Colon	0 (0)	27 (100)		
Creation of colostomy					
	Yes	0 (0)	8 (0)	35.174	0.000*
	No				
Duration of surgery					
	<2 hours	2 (20)	8 (80)	2.339	0.126
	>2 hours	7 (50)	7 (50)		

* Statistical significance is taken at p<0.05

However, this table also shows that there was no difference in SSI rates in terms of age or gender distribution. Pre-operative albumin and packed cell volume (PCV) were not significant contributors. Body mass index (BMI) was not included in the analysis as only seven (12.7%) patients had the required information for its calculation (weight and height) recorded. Likewise, variables with very few patients recorded were not included; only five (9.1%) patients had history of tobacco use, and six (10.9%) had history of alcohol ingestion. Only twenty-two (40%) patients were tested for HIV; all were negative. One patient was diagnosed diabetic pre-operatively. Nine (16.4%) patients had neo-adjuvant chemotherapy (IV 5FU), but none had pre-operative radiotherapy or steroid use.

Intra-operative contamination was reported in one patient who had abdomino-perineal resection (APR), who later developed superficial perineal incisional SSI discovered on sixth post-operative day. Intra-operative hypotension was noted in eight (36.4%) patients, four of whom had APR and developed SSI, with extended hospital stay. Majority (79.6%) had peri-operative blood transfusion, more than half (59.3%) of whom had 2 pints or less. Two (3.85%) patients had more than four pints transfused peri-operatively and one of them had SSI after APR, while the other, who had right hemicolectomy, did not have SSI.

Table 3: Multivariate analysis.

Variables	B	S.E	Wald	df	Sig	Exp (B)	95.0%C.I. for EXP (B)	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Surgery group	1.059	13802.323	0	1	1	2.882	0	
Bowel preparation	1.252	1.549	0.654	1	0.419	3.499	0.168	72.85
Tumour location	0.414	0.334	1.539	1	0.215	1.513	0.787	2.911
Blood transfusion	-0.757	0.799	0.897	1	0.344	0.469	0.098	2.246
Creation of stoma	-18.375	11750.468	1	0.999	0	0		
Constant						71580267		
						10384860		
	52.625	47556.352	1	0.999		0		

Variable(s) used in the equation: Surgery Group, Bowel Preparation, Tumour Location, Peri-op Blood transfusion, Creation of a stoma

Following the bivariate analysis, the variables pre-operative bowel preparation, peri-operative blood transfusion, colostomy creation, tumour location and surgical group were selected for multivariate stepwise logistic regression as their p-values for association with developing SSI were <0.05, the pre-determined cut-off for inclusion. However, none of them were found to be independent predictive factors, and as such, an oncology risk model for identification of high-risk score of patients could not be ascertained. Table 3 shows that the variables bowel preparation, tumour location and type of surgery increase the chances of developing SSI in this population of patients.

DISCUSSION

Our study shows a high rate of surgical site infection (SSI) for oncologic colorectal resections at 33.9%. This is higher than what has been generally reported in literature, which ranges widely from 3-30% with an average rate of roughly 10%.[1,2,4] To our knowledge to date, this series of post-operative SSIs after colorectal cancer surgery is the first of its kind in our region, where prevalence of nosocomial infections remains high. A wound infection rate of 17.4% after abdominal surgeries was reported in Lagos, Nigeria by Mofikoya et al, but this was not specific to colorectal surgeries.[8] However, Ukwenya reported an overall SSI rate of 25.3% for colorectal cancer surgery in north-western Nigeria, with significantly higher risk in operations on the rectum.[9] Our review of literature showed the highest SSI rate of 27.6% for rectal surgery and the lowest as 3% for incisional SSI.[10,11]

Notably, all SSIs recorded in our study were incisional, and all occurred after rectal surgery (SCAPR). This concurs with other studies that have shown that rectal surgeries are associated with a considerably high rate of SSI and are more prone to SSI compared to colon surgery.[5,9,10,12] Particularly, incisional SSI is higher in rectal surgery than in colon surgery.[2,5,10] Tang et al however noted that Hartmann's procedure and total/subtotal colectomy had higher SSI rate than colectomy, anterior resection, and even abdominoperineal resection (APR).[11] Previous studies have also shown that risk factors for incisional and organ/space SSI are distinct, and should be evaluated separately.[2,11,12]

This study was conducted only on patients who had open colorectal surgery for colorectal cancer, and not for other colorectal disease conditions. Studies have shown that primary disease diagnosis influences SSI in colorectal surgery and thus the disease process must be considered when designing appropriate interventions.[4,13]

Our study showed that pre-operative bowel preparation, peri-operative blood transfusion, creation of an ostomy, the tumour location and the type of surgery performed increased the likelihood of developing SSI in this cohort of patients. The increased risk of surgical infection associated with peri-operative blood transfusion has been documented following various operations, including colorectal resection.[14] Tang et al noted that blood transfusion was the most important risk factor in determining SSI, whether incisional, organ/space or anastomotic leak.[11] However, it was emphasized that the timing of transfusion was important, as pre-operative transfusion was not associated with higher SSI rates, but intra- and post-operative transfusion were. Jensen et al further elucidated the effects of transfusion of leukocyte-depleted blood and post-operative infection in colorectal surgery, supporting the hypothesis that allogenic leukocytes are partially responsible for transfusion-induced immunosuppression causing impaired immunity.[15] Blood transfusion was found to be an independently associated risk factor for organ/space infection in a previous study.[16] Avoidance of allogenic blood transfusion during elective colorectal surgery is thus recommended.

The use of diversion colostomy in anterior resection has been controversial, with demonstration from previous studies that it is not a protective factor against anastomotic leakage, but rather is an independent risk factor for incisional SSI.[2,11] It was also found to be a risk factor for organ/space SSI and for SSI after colorectal procedures in general.[10,16,17] It should be reserved for high-risk patients, or those with sphincter-saving procedures with low-level anastomoses situated at or less than 5 cm from the anal verge, particularly for men and obese patients.[11] In fact, colostomy closure itself is a risk factor for incisional SSIs among colonic surgeries, with a wound infection rate of up to 41%.[2] In our study, the creation of a diverting stoma was found to be associated with a higher risk for incisional SSI, albeit as a permanent one after SCAPR, and not as a protective colostomy. Three patients had anterior resection (without a protective colostomy) and three had hartmann's procedure, but none of them had documented SSI.

The location of the tumour and therefore the type of surgery performed were found to be associated with risk of developing SSI. Several studies have elucidated the distinction between SSI rates and risk factors for rectal surgeries and those of the proximal colon.[2,4,5,10] The involvement of total mesorectal excision (TME) as a routine component of anterior resection and abdomino-perineal resection (APR) was associated with high incisional SSI rates of up to 32%.[2] However, Singh et al found that a higher percentage of SSI were noted in patients who had hemicolectomies than those with rectal surgery.[18] Generally, low pelvic surgeries and low rectal anastomoses require longer time and greater skills on the surgeon's part and are understandably associated with more complications, including wound infection. Consequently, intra-operative variables such as the duration of surgery, intra-operative contamination, hypotension, hypothermia, and need for blood transfusion are potential risk factors in such surgeries. It is of no surprise therefore, that all the SSIs in our study occurred after rectal surgery and in particular, SCAPR.

Pre-operative bowel preparation used to be the gold standard in colorectal resections. Recently, its role has been questioned, and several studies have shown that it gives no significant added advantage in preventing SSIs.[2,14,19] Our study showed that there is a higher rate of SSIs (94%, p=0.026) in those patients who had bowel preparation, than those who did not. However, this may also simply be because those who had bowel preparation typically are those who had rectal surgery.

The role of prophylactic antibiotics in SSI prevention has also come under review recently. A shorter duration of prophylactic antibiotics was favored by Lohsiriwat et al, while Kobayashi et al showed the lack of advantage of adding oral antibiotics to intravenous antibiotics in terms of incidence of SSI.[20,21] In our centre, despite the absence of antibiotic prophylaxis protocol, those who had bowel preparation typically had oral antibiotics covering both aerobic and anaerobic organisms, plus one dose of intravenous antibiotic shortly before first skin incision, followed by multiple shots post-operatively for a variable length of time.

Simple but effective evidence-based measures like screening of patients for infections during pre-admission testing, use of hand-sanitizers to patient bed-post for use by clinicians, use of new set of instruments, gowns and gloves before closure, etc. have been found to help reduce SSI rates. A tertiary institution in the USA reported successful reduction in their overall SSI rate down to 4% and the superficial SSI rate from 4.9% to 1.6% with a multi-pronged approach using optimized evidence-based interventions pre-, intra- and post-operatively for colorectal surgery patients.[22] However, Aracil S et al in Spain found that SSI prevalence remained high despite similar measures.[10] Nevertheless, every effort to reduce to SSIs is worthy, considering the high morbidity and cost they confer to society. In addition, a study in the USA by Monn et al reported of post-operative infections in colorectal surgery patients being a risk factor for the development of venous thrombo-embolism (VTE), particularly organ/space SSI.[23] This risk further adds to the morbidity and increase in patient's hospital stay. It is recommended that a standard protocol for antibiotic prophylaxis and prophylaxis against venous thrombo-embolism in these kinds of patients be made routine.

Several important limitations of this study should be emphasized. First, this was a retrospective analysis, so the diagnosis of SSI was made by interpretation of documented findings on record and not by direct examination. This allows for the great possibility of inaccuracies and incompleteness of all variable data points. Several variables could not be assessed due to the small numbers recorded resulting from variation and incompleteness of documentation in some records. As such, important known predictors and potential risk factors like body mass index (BMI), ASA score, tobacco and alcohol use, diabetes mellitus, intra-operative hypothermia, to name a few, could not be evaluated. The need for proper documentation in patient records and reliable record-keeping and retrieval systems cannot be over-emphasized. The inability to retrieve all patient records in the period of study reduced the sample size, thereby affecting its statistical power. A prospective surveillance would clearly be a better measure. Despite these limitations, however, we think this study reflects actual SSI rates and highlights some potential risk factors for SSI in this patient population and data setting.

The SSI rate (33.9%) for colorectal cancer surgeries in this study is higher than what is generally reported. Surgery on the rectum and anus is more prone to SSI than surgery on the more proximal colon. The potential risk factors for incisional SSI include pre-operative bowel preparation, peri-operative blood transfusion, the creation of a stoma, the location of the tumour and the type of surgery performed.

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