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Factors Influencing Outcome of Sigmoid Volvulus in Northern Uganda. A Prospective Observational Study

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Introduction: ***Sigmoid volvulus (SV) is one of the commonest causes of intestinal obstruction in Uganda. The purpose of this study was to determine the factors influencing the outcome of SV in Northern Uganda.***
Methodology: ***A prospective observational study was conducted on 103 sigmoid volvulus patients admitted between January 2012 to December 2012 and surgically managed in 19 hospitals in Northern Uganda and followed up postoperatively for 30 days. Surgical management was by resection and primary anastomosis or Hartmann's procedure or double barrel colostomy. Patients 13 years and above with sigmoid volvulus and who had consented/Assented were included in the study and followed up to the 30th postoperative day. Ethical approval for the study was obtained from the Institutional Review Committee of Gulu University and Uganda National Council for Science and Technology. Data analysis was carried out using STATA/IC version 12.1. The outcome events were uneventful recovery, morbidity and mortality.***
Results: ***Eighteen(17.48%) patients developed complications including wound sepsis 10 (9.7%); wound dehiscence 8(7.7%) and anastomotic leak 8(7.7%). There were 8 deaths, giving a mortality rate of 7.7%. The factors associated with a high risk of adverse outcome were hypernatraemia (RR=14.9; 95% CI: 1.46-152.9) and ileo-sigmoid knotting (RR = 4.94; 95% CI: 1.30-18.78). Resection and primary anastomosis had a better outcome compared to Hartmann's procedure (RR=0.15; 95% CI: 0.02-0.099).***
Conclusion: ***The risk factors associated with morbidity and mortality were preoperative hypernatraemia and ileo-sigmoid knotting. Colostomy was associated with a higher risk of morbidity and mortality than resection and primary anastomosis.***

Keywords: Sigmoid volvulus, factors, influence, outcome
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Background

Sigmoid volvulus is a common cause of intestinal obstruction in developing countries and one of the commonest causes of intestinal obstruction in Uganda[1,2]. However, in the developed world, sigmoid volvulus is uncommon accounting for about 5% of all cases of large bowel obstructions[3]. In the developing world, sigmoid volvulus constitutes 50% of large bowel obstructions[4,5,6] and a multi-factorial aetiology has been implicated mainly food containing a high fibre diet and pre-existing redundant sigmoid colon[7,8]. In Uganda the basic foods include cassava, rice, millet, porridge, peas, soya, beans, oranges and mangoes which are high in fibre and have all been implicated in the aetiology of sigmoid volvulus[2]. It is postulated that this high fibre diet leads to a shortened intestinal transit time leading to a redundant sigmoid colon to undergo volvulus[9]. Studies conducted in Central and Eastern Uganda found that sigmoid volvulus affects mostly the Baganda, Basoga and Bagisu tribes however, Nilotics where this study was conducted, it was believed that they least often suffered from sigmoid volvulus[10].

Prolonged civil war, poverty, lack of specialist care and patients' unawareness in Northern Uganda may have contributed to the delay in reporting to hospital with acute sigmoid volvulus with the result that more advanced stages of bowel obstruction were often seen[11]. The obstructed bowel may become gangrenous as a result of strangulation, and this may lead to intestinal perforation, peritonitis and sepsis[12]. It was safer when the bowel was gangrenous to resect and leave a temporary stoma however, colostomy management is a problem in many rural areas because of unacceptability, unavailability and unaffordability of colostomy bags[13]. Resection and primary anastomosis was therefore carried out even when there is a gangrenous portion of sigmoid colon that has been resected with the result that they may experience increased morbidity from anastomotic leaks[14]. A study conducted in Africa has shown that co-

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morbidity is one of the most important determinants of outcome of sigmoid volvulus[14]. Many other studies have shown that most deaths are due to co-morbidities example cardiovascular disease, chronic respiratory disease and cancer[15,16]. Pre-operative shock on admission has been found to be associated with a poorer outcome of morbidity and mortality[14].

In a recent study conducted at St. Mary's Lacor Hospital in Northern Uganda it was found that age and co-morbidities were the main factors influencing outcome similarly to findings in Western countries[11] however, many factors including the haemoglobin concentration, white blood cell count, electrolyte pattern, vital signs, length of gangrenous sigmoid colon, presence of major peritoneal contamination, grade of surgeon and importantly the delay in hospital admission were not examined in that study.

Hence the purpose of this one year prospective study was to determine the factors that influence outcome of management of sigmoid volvulus in Northern Uganda.

Ptients and Methods

This was a prospective observational study which was conducted from January to December 2012 on a 30-day cohort of postoperative sigmoid volvulus patients.

Nineteen out of twenty Hospitals which serve 95% of the population of Northern Uganda recruited sigmoid volvulus patients consecutively. Of these Hospitals three were Regional Referral Hospitals. These were Arua, Gulu and Lira Regional Referral Hospitals. The remaining 16 Hospitals were Missionary and Government Hospitals including St. Mary's Lacor Hospital which is the largest Missionary Hospital with 482 beds. The other Hospitals were: St. Joseph's Maracha, Kuluva, Yumbe, Nebbi, Moyo, Adjumani, Kalongo, St. Joseph's Kitgum, Kitgum General, Angal, Nyapea, Apac, Matany, Aber, and Anaka Hospitals. The location of all the hospitals was in the Northwest (West Nile), Northern Region and North eastern region (Karamoja region) of Uganda, in East Africa.

The study population consisted of patients aged 13 years and above and with a peri-operative diagnosis of sigmoid volvulus and had given an informed consent by themselves or by gurdianco. The patients were recruited consecutively in each of these hospitals in Northern Uganda. Exclusion criteria included patients treated non-operatively and those who were not followed up to the 30th postoperative day. Patients' data was collected using a questionnaire on the following variables: patients' socio-demographic characteristics, period of symptoms prior to admission, co-morbidities, haemoglobin concentration, white blood cell count, electrolyte pattern, vital signs (preoperative heart rate and blood pressure), type of operation, presence of peritoneal contamination, length of gangrenous sigmoid colon, the presence of ileo-sigmoid knotting and grade of the surgeon.

The sample size for the prospective cohort study was calculated to be 98 patients. The sample size was increased by 5% to account for possible loss to follow up or non-response to the questionnaire and thus a total of 103 patients were recruited.The morbidity was determined by recording the postoperative complications over a 30-day period. This was done by conducting ward rounds twice a day while monitoring and investigating the presence of any particular morbidity being suspected during the whole study period. Mortality during this period was promptly investigated by conducting a postmortem examination and obtaining samples to determine the possible causes of death.Surgeons and staff involved in the study were trained to use a standard operative protocol. Trained research assistants transported serum samples for electrolyte analysis within 48 hours from all the Hospitals while maintaining a cold chain system to the central Laboratory of Gulu Regional Referral Hospital. A standard calibrated machine was used for analyzing the serum electrolytes and the results recorded in the questionnaire.

At laparotomy a suture was used to measure the length of gangrenous sigmoid colon which was then transferred to tape measure to determine the length of gangrenous sigmoid colon in centimeters. Being a multi-institutional study the operative procedure was standardized as much as possible by training the surgeons to use vicryl 2/0 and anastomose the bowel in double layers. Colostomy was also constructed using vicryl 2/0.

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The outcome of the surgical management of sigmoid volvulus included uneventful recovery, morbidity and mortality. The primary outcome for the study was a composite measure of morbidity and mortality.

Ethical approval was obtained from the Institutional Review Board of Gulu University, Institutional Review Board of St. Mary's Lacor Hospital and Uganda National Council of Science and Technology (UNCS&T). Informed consent/Assent was obtained from each individual patient taking into consideration the principles of good clinical practice.

Data analysis and interpretation was carried out using STATA/IC version 12.1. At univariate data analysis, the summary statistics were displayed for each key variable assessed against the outcome in order to obtain the relative risk (RR) at bivariate analysis. The associations between various independent and outcome variables was determined. Factors associated with postoperative outcome were calculated using chi-squared tests at 95% confidence intervals.

Multivariate logistic regression analysis was conducted to determine the factors independently associated with outcome. This was done by adjusting for factors with potential or actual confounding, as well as interaction. Variables in the bivariate model with p-value less than 0.2, or with a Relative Risk (RR) less than 0.5 or more than 2.0 (0.5<RR>2.0), or potential confounders were included in the final adjusted model. Any p-value less than 0.05 was taken as statistically significant.

Results

A total of 103 cases of sigmoid volvulus were recruited, managed and results eventually analyzed. The patients' ages ranged from 14-93 years, with a mean of (43.79 +/- 17.77) years. The mean age was 46.21 years for males and 37.54 years for females (p=0.036). There was a predominance of male 77 (74.8%) patients over female 26(25.2%) patients. The male to female sex ratio was 3:1.

The distribution of the patients by age groups was the following: 14-24 years 19(18.5%); 25-34 years 13(12.6%); 35-44 years 10(9.7%); 45-54 years 24(23.3%); 55-64 years 18(17.5%); 63-93 years 19(18.5%).

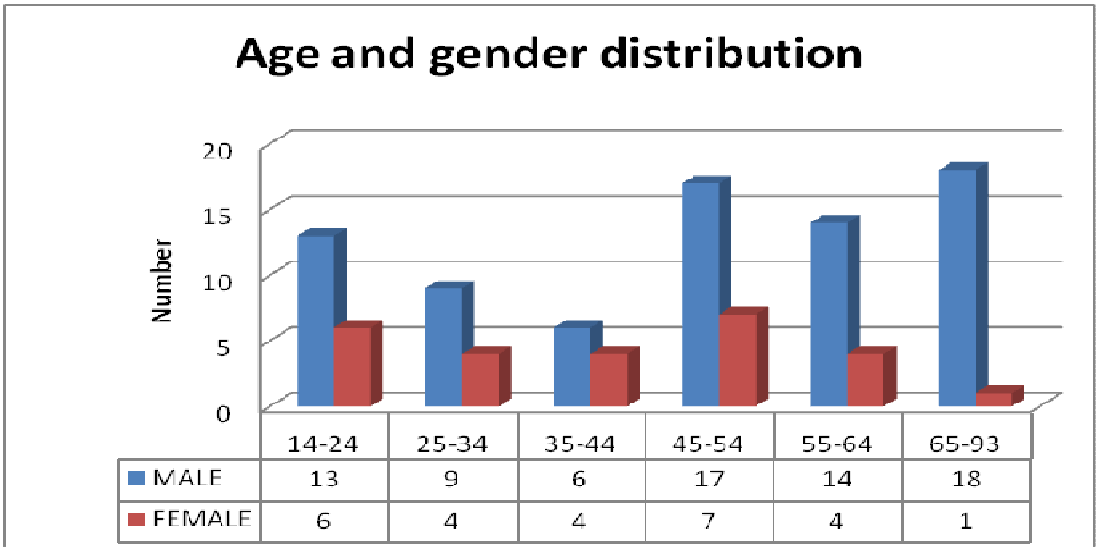

Fig.1. Age and Sex Ditribution

Vertical axis = number of new male and female patients with sigmoid volvulus
Horizontal axis = age ranges of patients with sigmoid volvulus

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The proportion of male patients increased with age and in all age groups there was a male predominance. In the 65-93 year age group 94.7% of patients were male and 5.26% were female. The proportion of female patients were highest in the 45-54 year age group however this was still lower than the proportion of male patients (Figure 1). The majority of patients, 61(59.2%), presented more than 3 days from the onset of symptoms. Only 42 (40.7%) of the patients presented within less than 3 days from the onset of their symptoms.

Pre-operative and post-operative antibiotics were given to all patients which included different combinations of antibiotics all given intravenously. There were three types of major surgical operations offered to patients with sigmoid volvulus. A total of 91(88.3%) of patients, had resection and primary anastomosis; 7 (6.8%) had a Hartmann's procedure and 5(4.9%) patients had resection and double barrel colostomy.

Post-operative complications included wound sepsis 10 (9.7%), wound dehiscence 8(7.7%), anastomotic leaks 8(7.7%), colostomy complications 7(6.8%), chest infections 6(5.8%), septic shock 6(5.8%), cardiac arrest 1(0.97%), hypertension 2(1.94%), abdominal abscess 1(0.97%), enterocutaneous fistula 1(0.97%) and urinary tract infection 1(0.97%) (Figure 2).

There were 8 deaths which gave a 7.7% mortality rate. The causes of death were: septic shock in 7 (6.8%) patients and cardiac arrest in 1(0.97%) patient.

Factors that potentially influenced outcome of Management of Sigmoid volvulus

Table 1 shows the final model of the multivariate analysis showing the individual factors which influenced the outcome.

Socio-demographic factors

Age: Increasing age was associated with an increased risk of developing an adverse outcome. In the adjusted analysis, the risk of an adverse event was higher among 65-93 year old patients relative to 14-44 year patients (adj. RR=2.45; 95% CI: 0.44-13.16), however this was not statistically significant (p=0.308) (Table 1).

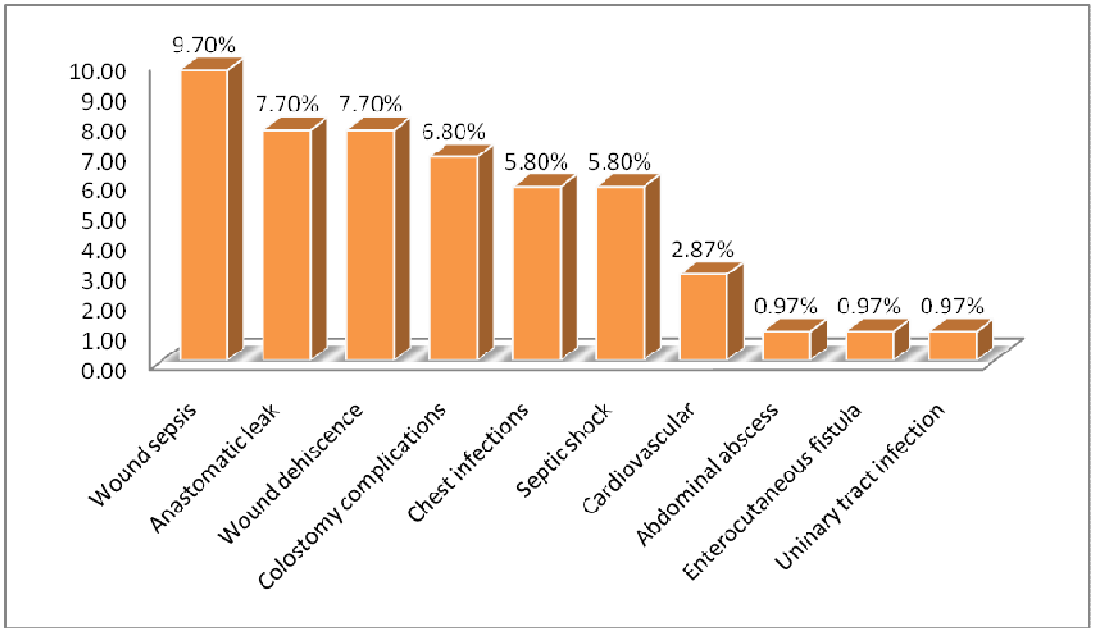

Figure 2.

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Table 1

	% Morbidity/ Mortality	Unadjusted RR*		Adjusted RR*		P-value for the adjusted
		Ratios	95%CI	Ratios	95%CI	
Overall	16.1					
Variables						
Sex						
Female	12.5	1.0		1.0		
Male	17.4	1.39	0.33,5.91	2.48	0.47,13.11	0.285
Age-group						
14-44	7.9	1.0		1.0		
45-64	18.0	2.27	0.58,8.88	0.78	0.27,2.26	0.644
65-93	31.3	3.96	0.81,19.39	2.42	0.44,13.16	0.308
Grade of Surgeon						
Consultant	54.6	1.0		1.0		
SMO/ MO/Registrar	11.0	0.20	0.07.0,0.58	0.24	0.02,2.35	0.219
Duration of symptoms						
< 3 days	10.3	1.0		1.0		
3 - 6 days	20.0	1.95	0.49,7.72	1.31	0.35,4.94	0.693
7 or more days	22.2	2.17	0.78,6.02	1.56	0.37,6.52	0.542
Pre-op BP and Pulse						
Normal	10.0	1.0		1.012		
Abnormal	16.9	1.69	0.22,12.69	2.86	0.67, 12.16	0.154
Length of gangrene						
0 cm	17.7	1.0		1.0		
1 – 18 cm	20.0	0.28	0.04,1.90	0.23	0.04,1.27	0.091
>18 cm	22.7	1.29	0.46,3.58	0.32	0.04,2.33	0.259
Pre-operative serum sodium						
Normal,135-145	8.7	1.0		1.0		
Hyponatraemia,<135	18.5	2.12	0.87, 5.17	3.33	0.44,25.47	0.246
Hypernatraemia, >145	20.0	2.30	0.20,26.30	14.9	1.46,152.9	0.023
Type of Operation						
Hartmann	66.7	1.0		1.0		
Resection	9.8	0.15	0.078, 0.27	0.15	0.02, 0.99	0.048
Double barrel	60	0.67	0.52, 0.85	3.59	0.08,167.3	0.514
Presence of ileosigmoid knot						
No	13.4	1.0		1.0		
Yes	36.4	2.71	0.95, 7.76	4.94	1.30, 18.78	0.019
Faecal contamination						
No	16.9	1.0		1.0		
Yes	10.0	0.59	0.10, 3.68	0.20	0.03, 1.48	0.115
Post-operative serum sodium						
Normal	12.0	1.0		1.0		
Abnormal	17.7	1.47	0.72, 2.99	3.16	0.38, 26.38	0.288
Post-operative serum potassium						
Normal, 3.5-5	21.4	1.0		1.0		
Hypokalaemia >5	8.3	0.39	0.15, 1.02	0.54	0.17, 1.66	0.282
Hyperkalaemia <3.5	7.7	0.36	0.06, 2.17	1.20	0.54, 2.66	0.659

Where RR* = relative risk; BP = Blood Pressure

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Sex: In the adjusted analysis, the risk of an adverse event tended to be higher among male compared to female patients (adj. RR=2.48; 95% CI: 0.47-13.11), however this association was not statistically significant (p=0.285) (Table 1).

Period of symptoms prior to admission

The mean overall duration of symptoms prior to admission was (2.82 +/-1.56) days. In the adjusted analysis patients that had symptoms for >3 days but <6 days had a risk of adverse outcome (adj. RR=1.31; 95% CI: 0.35-4.94), however this was not statistically significant (p=0.693). In the adjusted analysis, when the duration of symptoms was more than 7 days the risk increased even further (adj. RR=1.56; 95% CI: 0.37-6.52), however this was not statistically significant (p=0.542) (Table 1).

Vital signs

A normal pre-operative heart rate was taken as between 60-80 beats per minute. The mean pre-operative heart rate was (86.5 +/- 13.8) beats per minute. A normal pre-operative blood pressure was in the range of 110/70 mmHg to 130/85 mmHg. The mean systolic blood pressure was (117 +/- 22.8) mmHg whilst the mean diastolic blood pressure was (71.2+/- 15.1) mmHg. In the adjusted analysis, abnormal pre-operative vitals were associated with an increased risk of developing an adverse outcome (adj. RR=2.86; 95% CI: 0.67 – 12.16), however this was not statistically significant (p=0.154) (Table 1).

Haemoglobin Level

The normal range of haemoglobin in males was taken as 13.5 – 16.5 g/dl for males and 12.1 – 15.1 g/dl for females. The mean preoperative haemoglobin concentration was found to be (13.7+/- 2.1) g/dl. In the bivariate analysis, a low preoperative haemoglobin concentration tended to have a lower risk of adverse event (unadj.RR=0.89; 95% CI: 0.19-4.21). The mean postoperative haemoglobin was found to be 13.2g/dl (SD +/-2.45). In the bivariate analysis a low postoperative haemoglobin was found to have a risk of adverse event (unadj. RR=2.04; 95% CI: 0.57-7.30).

White blood cell count

The normal white blood cell count was taken as 4.3 – 10.8 x 10^9/ul. A white blood cell count of 11 x 10^9 /ul was considered a leukocytosis. The mean pre-operative white cell count was (9.9 x 10^9+/- 4.5 x 10^9)/ul. In the bivariate analysis a pre-operative leukocytosis was not found to influence outcome (unadj. RR=0.97; 95% CI: 0.34-2.80). The mean postoperative white cell count was (10.3 x 10^9+/- 4.28 x 10^9)/ul. In the bivariate analysis a postoperative leukocytosis tended to have a lower risk of adverse outcome (unadj.RR=0.86; 95% CI: 0.31-2.34).

Serum sodium levels

The normal serum sodium levels were taken as between 135-145 mmol/L. A value above 145mmol/L was taken as hypernatraemia and a value below 135 mmol/l was taken as hyponatraemia. The mean preoperative serum sodium levels were found to be (132.3+/- 12.8) mmol/l. In the adjusted analysis, hyponatraemia (<135 mmol/l) was found to have a risk of adverse outcome (adj.RR=3.33; 95% CI: 0.44-25.47) but this was not statistically significant (p=0.246). Patients presenting with a preoperative hypernatraemia (>145 mmol/L) were found to have a high risk of adverse outcome (adj. RR=14.9; 95% CI: 1.46-152.9) and this was statistically significant (p=0.023). The mean postoperative serum sodium level was (131.6 +/-7.55) mmol/l. There were only four (4) patients with a post-operative hypernatraemia so that these were combined with the sixty four (64) patients with a post-operative hyponatraemia and were analyzed as a combined abnormal serum sodium level. In the adjusted analysis, an abnormal post-operative sodium level was found to have a high risk of adverse outcome (adj. RR=3.16; 95% CI: 0.38-26.38) however this was not statistically significant (p=0.288) (Table 1).

Serum potassium levels

The normal serum potassium levels were taken as between 3.5-5 mmol/L. A value above 5mmol/l was taken as hyperkalaemia and a value below 3.5 mmol/L was taken as hypokalaemia. The mean preoperative serum potassium level was found to be (4.2+/- 2.1) mmol/l. In the bivariate analysis, preoperative hyperkalaemia was not found to have an adverse outcome (unadj. RR = 0.94; 95% CI: 0.34 – 2.57). The mean postoperative serum potassium level was (4.08+/-0.86) mmol/l. In the adjusted analysis,

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postoperative hyperkalaemia was associated with a higher risk of adverse outcome (adj. RR=1.20; 95% CI: 0.54-2.66) however this was not statistically significant (p=0.659). Although postoperative hypokalaemia tended to have a lower risk of adverse event (adj.RR=0.54; 95% CI: 0.17-1.66) this finding was not statistically significant (p=0.282) (Table 1).

Serum chloride levels

The normal serum chloride levels were taken as between 98-108 mmol/L. A value above 108 mmol/L was taken as hyperchloraemia and a value below 98 mmol/L was taken as hypochloraemia. The mean preoperative serum chloride level was found to be (101.2+/- 10.4) mmol/l. In the bivariate analysis, preoperative hyperchloraemia was found to have a risk of adverse outcome (unadj.RR = 1.64; 95% CI:0.49-5.53). The mean postoperative serum chloride level was found to be (101.7+/-6.7) mmol/l. In the bivariate analysis, post-operative hyperchloraemia was associated with a higher risk of adverse outcome (unadj.RR=1.84; 95% CI: 0.43-7.85). Although a postoperative hypochloraemia tended to have a lower risk of adverse outcome (unadj.RR=0.88; 95% CI:0.24-3.23).

Type of operation

There were 91(88.3%) patients that had a resection and primary anastomosis and only 5(5.5%) patients died. 8(7.8%) patients had a Hartmann's procedure and 2(25%) patients died. Four (3.9%) patients had a double barrel colostomy and 1(25%) patient died.

In the adjusted analysis, resection and primary anastomosis had a lower risk of developing an adverse outcome than a Hartmann's procedure (adj. RR=0.15; 95% CI: 0.02-0.099) and this was statistically significant (p=0.048). Similarly, a double barrel colostomy had a higher risk of adverse outcome than both resection and primary anastomosis and Hartmann's procedure (adj. RR=3.59; 95% CI: 0.08-167.3) however this was not statistically significant (p=0.514) (Table 1).

Length of gangrene of sigmoid colon

A median length of 18cm was taken as a cut-off to establish whether the extent of gangrene of the sigmoid colon had an influence on outcome. In the adjusted analysis, the presence of gangrene tended to have a lower risk of an adverse event (adj. RR=0.23; 95% CI: 0.04-1.27) however this was not statistically significant (p=0.091). Similarly increasing the length of gangrene of the sigmoid colon to greater than 18cm tended to have a lower risk (adj. RR=0.32; 95% CI: 0.04-2.33) however, this did not reach statistical significance (p=0.259). The mortality among 46(44.6%) cases presenting with gangrenous sigmoid colon was 10.87%. This contrasted with the mortality among 57(55.3%) non-gangrenous cases of 5.3% (Table 1).

Presence of ileo-sigmoid knotting

The presence of ileo-sigmoid knotting was seen in 13(12.6%) patients. In the adjusted analysis, ileo-sigmoid knotting was associated with a higher risk of adverse outcome (adj. RR=4.94; 95% CI: 1.30-18.78) and this was statistically significant (p=0.019)(Table 1).

Presence of faeculant contamination

In the adjusted analysis, faecal contamination was not found to increase the risk of adverse outcome (adj. RR=0.20; 95% CI: 0.03-1.48) however, this was not statistically significant (p=0.219) (Table 1).

Grade of surgeon

The majority of laparotomy 91(84%), were carried out by the Medical Officer, Senior Medical Officer and Registrars. Only 17(16%) laparotomies were carried out by Consultant surgeons. In the adjusted analysis, Consultant surgeons were found to have a higher risk of adverse outcome than the Medical Officers, Senior Medical Officers and Registrars (adj.RR=0.24; 95% CI: 0.02-2.35) however this was not statistically significant (p=0.219)(Table 1).

Co-morbidity

There were only four co-morbidities in this study which was very low. Two patients had hypertension, one patient had diabetes and the last patient had neuro-psychiatic illness. Out of these four patients

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presenting with co-morbidities only one patient, the diabetic died of a hypostatic pneumonia, otherwise the rest had an uneventful recovery.

Discussion

The population of Northern Uganda is mainly rural people and a large number of them are peasant farmers[17]. These peasant farmers consume cereals and high fibre crops like maize, cassava, millet, mangos and beans[17]. In a study carried out by Tumusiime *et al* in Central Uganda, this diet was found to make them more susceptible to sigmoid volvulus[2]. The high consumption of these high fibre crops may lead to increased gas formation in the bowel, predisposing them to sigmoid volvulus[14].

In this study the 45-54 year age group had the greatest number of cases. This study showed no statistically significant association between age and outcome (p=0.308) and is in keeping with findings from another study by Jumbi et al., 2008. Many studies from the West have shown that increasing age and co-morbidity affects outcome[18,19]. In the Western population the mean age of presentation with acute sigmoid volvulus is 62-78 years whilst in the African population it is 42-55 years[14]. The low mortality of 7.7% seen in our young study population compared with the high mortality rates seen in an older cohort of patients in developed countries means that advanced age has a significant effect on outcome.

There was a male predominance (74.8%) of sigmoid volvulus in this study and these findings are consistent with those of Atamanalp et al.,2005 and other studies but no statistically significant correlation was observed[20].

Co-morbidity tends to be higher in the Western population than in the African population. Studies by Hiltumen *et al* and Ghosh *et al* in Western populations showed that co-morbidity is a major cause of mortality[15,21]. The co-morbidities responsible for most cases are usually secondary to cardiorespiratory disease and carcinoma. A very low mortality rate of 7.7% compared to the higher mortality rates seen in Western populations is most likely due to a combination of a younger age and low co-morbidity seen in this patients' cohort.

Most patients presented more than 3 days after the onset of symptoms. This could explain the higher percentage of patients presenting with gangrenous sigmoid colon (44.7%) in our study. Previous studies have shown that the circulation to the bowel may be compromised if the volvulus is present for more than 6 hours resulting in gangrene of the bowel[22]. This study showed a higher risk of adverse outcome if the duration of symptoms was more than 3 days and the risk increased even further above 6 days however this was not statistically significant (p=0.542). Similarly another study by Jumbi *et al*, reported similar findings[13]. The possible explanation is that the gangrenous sigmoid colon when present for more than 6 hours may lead to perforation and septicaemia resulting in a poorer outcome. The finding from this study should encourage surgeons and other health workers in our community to raise public awareness on reporting early to Hospital when a patient has features of intestinal obstruction. Heath education, creating awareness and improvement in public health services should address the problem of a delay in admission with acute sigmoid volvulus to Hospital.

This study found that preoperative shock was associated with adverse outcome however this was not statistically significant (p=0.154). There was one death from eight patients that presented with preoperative shock, which gave a mortality rate amongst patients presenting with pre-operative shock of 12.5%. These findings are consistent with studies carried out by Bhuivan *et al* and Kuzu *et al*, that have shown that preoperative shock on admission is associated with a poorer outcome[23,24].

Post-operative anaemia was found to have a high risk of adverse outcome in particular wound sepsis. Stephen *et al.,* found that in patients undergoing laparotomy for colonic resection, post-operative anaemia was a risk factor for stroke, myocardial infarction and renal insufficiency[25]. However these complications were not seen in this study. A longer hospital stay was seen in patients who developed post-operative anaemia in this study. This finding is in keeping with findings from Stephen *et al.,*who found that patients with a post-operative normal haemoglobin concentration have a reduced length of hospital stay compared to those developing post-operative anaemia[25].

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White blood cell count: In this study, leukocytosis did not have any significant effect on the outcome of surgery. However this is contrary to the findings found in other studies, where leukocytosis was found to be associated with an increased risk of anastomotic leakage of between 12-30% following large bowel resection[26].

Serum electrolyte levels: This study showed that pre-operative hypernatraemia was significantly associated with adverse outcome (p=0.023). Pre-operative hyponatraemia was also associated with adverse outcome but these were not statistically significant (p=0.246). Pre-operative serum hyperkalaemia and hypokalaemia did not show any increased risk in adverse outcome whilst post-operative hyperkalaemia had a slightly increased risk however this was not statistically significant (p=0.659). Studies carried out by Morris-Jones *et al* and Arieff *et al*, have shown that sodium imbalance can cause confusion, seizures, cerebral bleeding and death[28,29]. Potassium imbalance may cause arrhythmias and cardiac arrest which may lead to death[29], however none were reported in this study.

In colonic obstruction fluid and electrolyte disturbances in particular of sodium, potassium and chloride take place[27]. This study which showed that preoperative hypernatraemia was statistically and significantly associated with adverse outcome (p=0.023). This contrasts with findings by Nurkal *et al*, who found that hyponatraemia, hypernatraemia, hypokalaemia and hyperkalaemia were not found to have a significant effect on morbidity and mortality (p>0.05) in patients presenting with colonic obstruction[27]. These findings reinforce the importance of correcting electrolyte imbalance in particular hypernatraemia prior to emergency laparotomy for acute sigmoid volvulus.

A limitation of this study is that fluid imbalance was not determined as several studies have shown that adequate fluid resuscitation is important in the management of patients presenting with bowel obstruction[30]. In a study carried out by Nisanevich *et al*, correct fluid management was found to reduce post-operative morbidity and shortened the length of hospital stay[30]. Jumbi *et al*, also found a significant association between intravenous fluid therapy and outcome in patients undergoing emergency resection for acute sigmoid volvulus (p=0.0406)[13]. These findings on hypernatraemia coupled with the findings on fluid imbalance from Jumbi et al and Nisanevich et al reinforce the importance of correcting electrolyte and fluid imbalance prior to laparotomy in patients with acute bowel obstruction.

The majority of surgical procedures, carried out in this study were resection and primary anastomosis. A large proportion of patients who survived had a resection and primary anastomosis of the sigmoid colon. This study showed that the risk of a resection and primary anastomosis was lower than for a Hartmann's procedure and double barrel colostomy and this was statistically significant (p=0.048). The risk was higher for stoma formation and in particular for Hartmann's procedure possibly because all these patients presented later than 48 hours, had gangrenous sigmoid colon and were septic on admission, so that the outcome may not be related to the stoma itself.

For all cases the mortality was 4.8% for resection and primary anastomosis and 23% for colostomy. Whilst in patients undergoing resection and primary anastomosis the mortality rates were low with 5.26% for viable gut and 10.8% for gangrenous gut. The findings in this study contrast to those of Bagarani *et al*, who reported a 60% mortality rate for resection and primary anastomosis for gangrenous sigmoid colon in a study carried out in West Africa[31]. There is a large variation in the literature when one compares the outcome of resection and primary anastomosis versus colostomy. The findings of this study contrast with those of Aekan *et al* and Okello *et al,* where there was no significant difference between resection and primary anastomosis or colostomy in terms of morbidity and mortality[11,32].

The length of Hospital stay in this study was 13.4 days for patients undergoing resection and primary anastomosis. This is comparable to the length of hospital stay of 7-14 days in a study carried out by Sule *et al* on 27 patients undergoing resection and primary anastomosis[5] and there was no anastomotic leakage and no mortality recorded in the same study. Similar to findings in this study, Sule *et al* found that in patients undergoing resection and primary anastomosis the length of Hospital stay was shorter than for those undergoing a staged procedure[5]. Therefore it may be stated that emergency resection and primary anastomosis is cost effective, safe, reduces the recurrence rate, reduces hospital stay and avoids

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a stoma. In communities where a colostomy is unacceptable, unaffordable and where appropriate toilet facilities are lacking such as in many parts of Northern Uganda, resection and primary anastomosis is therefore a viable option even when gangrenous gut is present.

In our community there is a trend to perform more resection and primary anastomosis depending on the general physiological condition of the patient. However, it is still remains unclear whether the choice of operation really influences outcome. In this study, the two groups of patients were not similar enough in order to make a conclusive comparison and therefore to compare the outcome of the different surgical procedures a randomized clinical trial may need to be carried out emphasizing the limitation in this study.

The length of gangrenous sigmoid colon did not have any significant influence on the outcome of surgery. This is consistent with other studies in particular Jumbi *et al*, who also found no significant difference in the outcome of patients having gangrenous sigmoid colon(p=0.5046)[13]. The reason was possibly because more care was taken by the surgeons to resect the colon down to healthy viable colon and anastomose the bowel ends with no tension. Furthermore, this study showed a very low mortality rate of 10.8% for gangrenous sigmoid colon. This was lower than the average mortality of 38% found in South Africa[14]. This mortality rate with gangrenous sigmoid colon is lower than the average global mortality of 35.3%. This low mortality is the lowest found in all African series and possibly explains the reason behind gangrenous sigmoid colon not influencing outcome of management of surgery.

Ilio-sigmoid knotting had a higher risk of developing an adverse outcome and was statistically significant (p = 0.019). These findings are consistent with studies carried out by Gibney *et al*., and Mallick *et al.,* that have shown that ileo-sigmoid knotting is associated with a high risk of adverse outcome[33,34]. The possible reason for ileo-sigmoid knotting adversely affecting outcome is that these patients presented with gangrene of the sigmoid colon and small bowel and were septic on admission. The high mortality rate of 38.4% in this group of patients compares favorably with the high mortality rates seen in other studies. Shepherd et al., found a mortality rate as high as 50% in patients with ileo-sigmoid knotting[7]. However, our findings contrast with another study, where it was found that ilio-sigmoid knotting was not associated with an increased risk of morbidity and mortality[13]. From my observations, in these patients laparotomy should not be delayed as the surgeon is confronted with the prospect of resecting both the small bowel and sigmoid colon in a very sick patient.

Peritoneal contamination did not have any significant influence on the outcome of surgery (p=0.115). The possible reason was that only a small number, 15(14.5%) patients were seen. Furthermore in these patients the surgeons took extra care in washing the peritoneal cavity with copious amounts of normal saline. There were no anastomotic leaks reported from these patients. These findings contrast with those of Bagarani *et al* and Kocak *et al* who found a high rate of anastomotic leakage in the presence of faecal peritonitis as a result of perforated sigmoid colon and as a result of this finding recommend a colostomy[31,35].

The majority of laparotomies (84%) were operated by Medical Officers, Senior Medical Officers and Registrars. The Consultant surgeons only operated on 16% of patients and were found to have a higher risk of adverse outcome compared to the Medical officers however this was not statistically significant (p=0.219). These findings were comparable with those from Kitara et al., 2010 and Jumbi et al., 2008 where the grade of the surgeon was not found to be related to outcome. However, these findings contrast with those of Bennett-Guerrero *et al*, who found that there is a correlation between high risk surgery performed by surgeons in training and poor postoperative outcome[37]. One must appreciate that the patients operated by the Consultant surgeons tended to have higher physiological risk scores and had abnormal preoperative vital signs on admission. In view of the small number of patients operated by Consultant surgeons and the findings that lacked statistical significance, one cannot conclude that the grade of the surgeon influences outcome.

The morbidity and mortality rates following laparotomy for sigmoid volvulus vary between developed and developing countries. The overall mortality rate of sigmoid volvulus in our study was 7.7% which is low compared to mortalities of up to 58% seen in developed countries[38]. Studies carried out in the West

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by Grossman *et al*, have also shown a higher mortality in developed countries than in Africa[18]. Earlier studies had reported a mortality of 58% and 37% respectively[38,39]. Madiba *et al*, in South Africa also reported a high mortality of 30%[14] as have other studies in different parts of the world showed a higher mortality rate following emergency resection compared to elective resection[14,18].

Wound sepsis was the commonest complication 10(9.7%). This finding was similar to that found by Kitara *et al,* at 9.9%[36] .Wound sepsis mainly presented on the fourth to seventh postoperative day in patients presenting with purulent or faeculant peritonitis. These findings contrasted with those of Rousellot *et al*, in the US who found a higher incidence of wound infection at 15% and it was found to be the commonest postoperative complication[40]. The second commonest complication was abdominal wound dehiscence 8(7.7%). The patients who developed wound sepsis nearly all developed abdominal wound dehiscence and this may explain the nearly similar incidence in both complications. The findings however contrasted with those found by Mugisa *et al,* who found a higher rate of 15% which he accounted this to poor surgical technique by junior residents[41].

The incidence of anastomotic leakage 8(7.7%) in our study was similar to results from other African studies[21,23].In this study the bowel was unprepared in all cases prior to resection. There is evidence from other studies that anastomosis on unprepared bowel is a safe option[42]. Mealy *et al*carried out 126 emergency bowel resections with no preoperative bowel preparation. He found only 3(2.4%) anastomotic leaks and no mortality[42]. The slightly higher anastomotic leakage of 7.7% in our study could be due to a deficiency in surgical material and technique as many were performed by Medical Officers.

Colostomy complications were the fourth commonest complication 7(6.8%) and this morbidity rate is comparable to that found in other Africa studies[31]. The majority, 6(85%) were due to surrounding cellulitis and 1(14%) case was due to retraction of the stoma. Chest infection was the fifth common complication 6(5.8%). This is in contrast to the findings by Kitara *et al*, where chest infections where found to be the commonest postoperative complication following laparotomy[36]. This may be explained by the fact that many of the abdominal incisions used for emergency sigmoid resection were lower midline sub-umbilical incision and therefore patients had less postoperative pain.

The other morbidity rates for septic shock 6(5.8%), cardiovascular complications 3(2.9%), intra-abdominal abscess 1(0.97%), enterocutaneous fistula 1(0.97%) and urinary tract infection 1(0.97%) were comparable with results from other African and Asian studies[5,23,43]. There were no cases of wound haemorrhage in this study. A study conducted in Uganda showed a 10% rate of wound haemorrhage in patients operated by Senior House Officers[41].

There were also no cases of thromboembolism reported in this study. The explanation was probably because this study involved a younger population and sigmoid volvulus is a benign condition. This is in contrast to the findings by Aagard who found a 15% prevalence of thromboembolism in patients above 50 years of age undergoing laparotomy[44].

Conclusions

The risk factors significantly associated with morbidity and mortality in the surgical management of sigmoid volvulus were preoperative hypernatraemia and ileosigmoid knotting. Colostomy was associated with a higher risk of morbidity and mortality and a longer hospital stay than resection and primary anastomosis.

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