Why, When and How to Perform One Layered Bowel Manual Anastomosis After Colonic Resection?

Felix Mutale, Mwila Lupasha, Sidney Shampile, Felix Michelo, Mabvuto Mwanza and Etienne BFK Odimba*

Department of Surgery University Teaching Hospitals, Adult Hospital, Lusaka, Zambia

*Corresponding Author: Etienne BFK Odimba, Department of Surgery University Teaching Hospitals, Adult Hospital, Lusaka, Zambia.

Abstract

There are conflicting views on the use of single versus double layer technique of large bowel anastomosis. Historically, two-layer anastomosis has been the conventional method for most surgical situations. But it is tedious, time-consuming and there is still potential risk of anastomotic stricture formation. Single layer extra mucosal continuous intestinal anastomosis can be constructed in significantly shorter duration. No dogmatic evidence suggesting that double layered anastomosis is superior to single layered closure of bowel anastomosis. The role of demographic and clinical factors in aetiology of anastomotic leak is not yet completely understood.

The aim of this study was to investigate the associated factors and occurrence of anastomotic leak following single- and double-layer large bowel anastomosis at the University Teaching Hospitals, Adult Hospital in Lusaka, Zambia.

A cross-sectional study with an analytic component was conducted to identify factors and occurrence associated with anastomotic leak in single- or double-layer anastomosis technique. Convenience sampling was used to recruited sixty (60) participants. Thirty-three were allotted in single layer group while twenty-seven were allotted to a double layer group. They were matched for sex, age, past medical history and clinical diagnosis. Using SPSS version 22, both univariate and multivariate logistic regression were used to analyse data. The technique and Factors associated with anastomotic leak having a p-value of < 0.05 was considered significant.

Among patients who underwent single layer technique of anastomosis 40% had a leak compared to 60% in double layer technique, though the P value in both groups remained insignificant with regard to various factors. The crude and adjusted olds ratios on the logistic regression shows that the olds of anastomotic leak in either gender and corresponding age group increased by 7.91 and 7 folds with unit decrease in albumen and haemoglobin respectively. Males were four times more likely to leak than females. Haematocrit, diagnosis and age between 18 to 65 years had no influence on anastomosis leakage.

This study concluded that patients' demographics and clinical characteristics play a great role in large bowel anastomosis irrespectively of the method of primary anastomosis. Preoperative assessment of these factors and appropriate intervention would improve outcome of large bowel anastomosis. The single layered extra-mucosal continuous or interrupted intestinal anastomosis is equally as safe and more cost effective than conventional double layered technique and deserved to be trained in our settings.

Keywords: *One Layered Multi-Layered Bowel Anastomosis; Anastomotic Leak; Associated Factors*

Why, When and How to Perform One Layered Bowel Manual Anastomosis After Colonic Resection?

86

Introduction

The indications for large bowel resection and primary anastomosis include malignancy, perforation, gangrene, benign conditions like polyps, diverticulosis, enteritis and strictures. There are various types of anastomosis orientations such side to side, end to end and end to side. Anastomotic leak is a 'leak of luminal contents from surgical join' leading to peritoneal contamination and peritonitis. They usually present between 5 to 7 days post operatively with peritonism. It constitutes a main concern after any bowel resection surgery necessitating anastomosis on mono or multilayered construction. The basic principles of the intestinal suture were established more than 100 years ago by Travers, Lambert, and Halsted. Different techniques of intestinal anastomosis cited in 2006 by Michael J [1] are single, double layered closure, staples, glue, and laser welding. There is no dogmatic evidence suggesting that double layered anastomosis is superior to single layered closure of bowel anastomosis as noted by Saravanan.

What can be said on the procedure is that the surgeons performing one single layer does it extra-mucosal technique with absorbable suture such as vicryl 2-0 or another suture, making sure that the mucosa layer is not sutured and stays entirely in the lumen; while in double-layer or more, continuous technique a Vicryl 2-0 takes through all layers including the mucosa and the outer layer seromuscular layer is sutured with 3-0 silk or other non-absorbable or semi-absorbable. So, despite historically two-layer anastomosis has been the conventional method for most surgical situations, it is tedious, time-consuming and there is potential risk of anastomotic stricture formation.

A prospective study on 72 patients with end-to-end single interrupted extramucosal anastomoses using polyglactin was done and found that Single layer extramucosal interrupted suture gut anastomosis is a safe technique. For Muhammed in 2009 [2] it is suitable for all anastomoses in the gastrointestinal tract. Different trials and clinical studies have proven the superiority of single layer anastomosis, which besides being quicker to create, are apparently as strong as two-layered anastomosis as noted by Satora S. Recently, single layer continuous anastomosis using monofilament suture has been adopted by many surgeons due to reports describing its cost effectiveness, less time consumption, and no increase in rates of leakage as compared to double-layer method.

Large bowel is potentially contaminated, and anastomosis done on it risk infection and eventual break down. Bowel preparation in elective settings is recommended to clear faecal material from the lumen prior to surgery in elective cases to reduce the risk of a leak. Anastomosis healing consists of a complex process that involves the interaction of predictable, orderly, and time-dependent components. Wound healing failure occurs when there is an abnormality in either the degree or duration of one of the components of tissue repair. Local and systemic factors may cause failure of gastrointestinal healing. General factors include age, sex, circumstances whether elective or emergency surgery, sepsis, drugs like corticosteroids and immune suppressive. The role of systemic factors in aetiology of anastomotic leak is not yet completely defined. Among systemic factors at least three of them do seem to play a significant role and they are: Poor nutrition (serum albumin level below 34 g/L), anaemia (Hb below 11 g/dl and haematocrit below 33%), excessive blood loss, therapeutic radiotherapy. The local blood supply and the integrity of the mucosa inside the lumen play a great role.

There are conflicting views on the use of single versus double layer method of anastomosis among different surgical units at University Teaching Hospitals. Different surgical units have different views, but the outcomes are not documented. Burden of surgery at the university teaching hospital in Lusaka indicate that from January 2020 to December 2020 there was 65 large bowel primary anastomosis due to sigmoid volvulus in Phase 5 Operating Theatre alone. The method of anastomosis used in about 90% in this time, was double layer method and there were 3 patients with anastomotic leak, however, the occurrence and factors associated with large bowel anastomosis leak were not documented leading to the knowledge gap. The documented research at UTH on Anastomotic leak was 15 years ago hence, no data on current trends. In his dissertation study, Nthele M [3] in 2006 showed that, between May 2005 and April 2006, 276 laparotomies were done at UTH, and 9% (25) of these were relaparotomies. 60% of relaparotomies were due to anastomotic leaks. There was 40% mortality on relaparotomies, 67% of which were secondary to Anastomotic. Therefore, anastomotic leakage represents a challenge

at UTH where have scarcity of sutures and theatre time among other limitations. A method of anastomosis with lesser leakage would a good practice if established in our setting.

What are Factors associated with occurrence of anastomotic leak following single- and double-layer large bowel anastomosis at the University Teaching Hospitals, Adult Hospital, in Lusaka, Zambia?

Objective of the Study

The general objective is to investigate the associated factors and occurrence of anastomotic leak following single- and double-layer large bowel anastomosis at the university teaching hospital in Lusaka, Zambia.

As specific objectives the study aims to

1. Ascertain the social demographic and clinical characteristics of patients undergoing large bowel anastomosis using single or double layer.

2. Determine the prevalence of anastomotic leak in patients undergoing single- and double-layer method.

3. Identify factors associated with occurrence of anastomotic leak following single or double-layer large bowel anastomosis.

Methodology

In this research, a cross-sectional study with analytic component was conducted to identify factors and occurrence associated with anastomotic leak in single-and double-layer anastomosis techniques at the five general surgical units of the Adult Hospital of the Lusaka University Teaching Hospitals. The population study was constituted by all patients admitted to surgical wards with large bowel surgical pathology undergoing resection and primary anastomosis both emergency and elective cases will be offered either method of anastomosis according to the hospital protocol.

The target population included only patients requiring large bowel primary intestinal anastomosis with as including criteria: age between 18 years and 65 years, patients undergoing resection and anastomoses of large bowel or for Colostomy reversal, on emergency and elective situation and under contentment. However, were excluded cases of ileocolic anastomosis.

The sample size was determined following the calculation formula and based on global prevalence rates of 3.7% estimated by Muhammad [2] in 2006 and that led to a sample size of 60 taking in account the latest Zambia Demographic and Health Survey.

The principal researcher used non-probability convenience sampling in which the study units that was available at the time of data collection was selected in the sample. The participants were patients with large bowel pathology and required bowel resection and primary anastomosis using either double or single layer technique. This means participants were selected and recruited into the study only at the time of surgery. They were followed up throughout the six weeks period of reviews. Scrutiny was made of the medical file, logbooks in surgical ward and operating theatres. Where the medical records were vague, the patient was asked to clarify.

Conceptual framework

On this conceptual framework, Surgical technique constitutes local factors while demographic and clinical characteristics and patient's past-medical history systemic or general factors
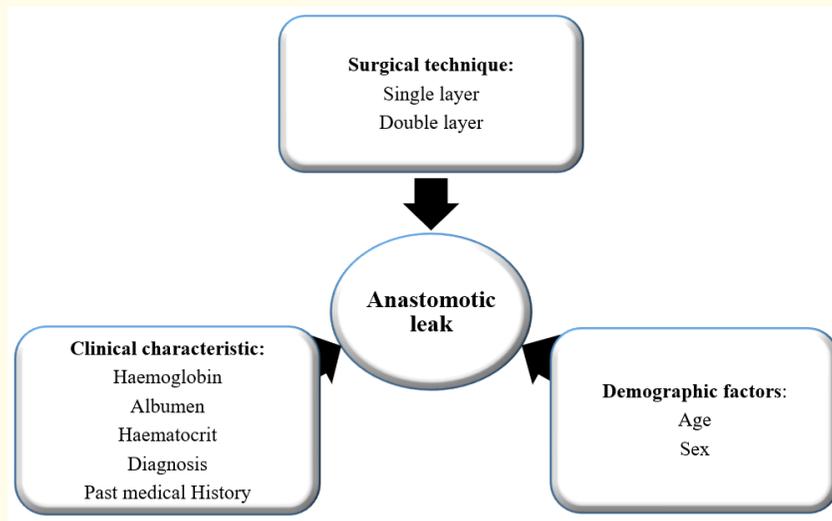
Figure 1: Conceptual framework.

Data management

A structured questionnaire including all variables was constructed from theatre book list: file number, type of primary anastomosis confidently coded randomly one asor double layer, hospital stay, brief socio-demographics, past and present medical history, mode of anastomosis and outcome variables such a leak. All the independent variables as well as the confounders were considered by capturing them in the history, examination, investigation, and the type of anastomosis done during data collection and analysis to ensure the validity as well as history taking and surgical preparation to ensure the reliability. The variables are illustrated on table 1.

Independent Variables	Dependent Variable
Socio-demographic variables: Age and Sex	
Past medical history variables:	Anastomotic Leak
Clinical variables: Haemoglobin, Albumin, haematocrit. Method: single or double	

Table 1: Variables.

Data analysis

Data was entered into excel spreadsheet to check for completeness, consistency, legibility, and accuracy and then coded and later exported to SPSS version 28.1 for analysis. Descriptive statistics were computed for all variables as frequencies and proportions (percentages). Bivariate analysis was done using Chi-square test between anastomotic leakage (dependent factor) and independent factors, and proportions, frequencies and p values were computed to ascertain association. Analysis of variance (ANOVA) test was done to assess linearity and compute significance of differences between the averages of all haemoglobin, haematocrit, age, and albumin concentrations. To assess the association and control for confounding between anastomotic leakage and independent variables, binary logistic (univariate and multivariate) regression (using the backward conditional model to control the confounding effect of independent variables) was done. Odds ratios (both crude and adjusted), p values and 95% confidence intervals were computed to estimate the effect of independent factors on anastomotic leakage. In all analyses, a p value of less than 0.05 was considered statistically significant.

Ethical considerations

The study was approved by the University of Zambia Biomedical Research Ethics Committee (UNZABREC) and national health research ethics (NHRA), REF 1883-2021. Permission to conduct it was granted by the Adult Hospital's medical superintendent. Only patients who consented were recruited in this study, and anonymity was ensured.

Limitations

The main challenges of the study were to find complete patients' complete medical records and others did not consent and so were excluded from the study.

Why, When and How to Perform One Layered Bowel Manual Anastomosis After Colonic Resection?

89

Results and Discussions

Characteristics associated with recruited patients undergoing large bowel anastomosis using single or double layer

Among the sixty patients recruited, thirty-three were allotted in single layer group, twenty-seven in double layer group. They were matched for sex, age, past medical history and clinical diagnosis. Majority of patients (63.4%) were between 20 to 49 years with an aver-age age of 45 years. Males were four times more than women. Only four patients had significant past medical history. In terms of diagnosis: 53.3% had sigmoid volvulus, followed by colorectal cancer at 23.3%, while colostomy reversal and colon injury were at 5% each and the least of diagnoses were ileosigmoid knotting and adhesion band at 1.7% each. The patients that had anastomotic leak were 10 translating in 16.7% leak rates. The average haematocrit was 38% and 48.3% of patients had normal values while 15% and 36.7% hand above and below normal respectively. The average haemoglobin was 12.5 g/dl and 60% of patients had normal while 38.3% had below normal and 1.7% had above normal. The average albumen was 37.2 g/L and 33.3% had values below normal while 66.7% they had normal values. The table 2 summarizes the descriptive characteristics of the 60 participants.

Variables	Anastomotic Leakage		Total	p value
	No leakage (n = 50)	Leakage (n = 10)		
Age (Years)				0.597
20 - 29 years	12 (24%)	1 (10%)	13 (21.7%)	0.331
30 - 39 years	9 (18%)	3 (30%)	12 (20%)	0.391
40 - 49 years	10 (20%)	3 (30%)	13 (21.7%)	0.487
> 50 years	19 (38%)	3 (30%)	22 (36.7%)	0.635
Gender				0.403
Female	9 (18%)	3 (30%)	12 (20%)	0.391
Male	41 (82%)	7 (70%)	48 (80%)	0.391
Previous Medical History				0.003*
None	49 (98%)	7 (70%)	56 (93.3%)	0.001*
Hypertension plus RVD	0 (0%)	1 (10%)	1 (1.7%)	0.025*
Hypertension only	0 (0%)	1 (10%)	1 (1.7%)	0.025*
RVD only	0 (0%)	1 (10%)	1 (1.7%)	0.025*
Diabetes mellitus	1 (2%)	0 (0%)	1 (1.7%)	0.655
Diagnosis				0.632
Adhesion bands	1 (2%)	0 (0%)	1 (1.7%)	0.655
Ileosigmoid knotting	1 (2%)	0 (0%)	1 (1.7%)	0.655
Gun shots	1 (2%)	1 (10%)	2 (3.3%)	0.202
Colostomy reversal	5 (10%)	0 (0%)	5 (8.3%)	0.300
Colon injury	5 (10%)	0 (0%)	5 (8.3%)	0.300
Colorectal cancer	11 (22%)	3 (30%)	14 (23.3%)	0.588
Volvulus	26 (52%)	6 (60%)	32 (53.3%)	0.646
Technique				0.322
Single	29 (58%)	4 (40%)	33 (55%)	0.300
Double	21 (42%)	6 (60%)	27 (45%)	0.300
Haematocrit (%)				0.245
< 35%	16 (32%)	6 (60%)	22 (36.7%)	0.096
35 - 45%	26 (52%)	3 (30%)	29 (48.3%)	0.208
> 45%	8 (16%)	1 (10%)	9 (15%)	0.631
Haemoglobin (g/dl)				0.291
< 12 g/dl	17 (34%)	6 (60%)	23 (38.3%)	0.126
12 - 17g/dl	32 (64%)	4 (40%)	36 (60%)	0.161
> 17 g/dl	1 (2%)	0 (0%)	1 (1.7%)	0.655
Albumin (g/L)				0.012*
< 35 g/L	13 (26%)	7 (70%)	20 (33.3%)	0.008*
35 - 60 g/L	37 (74%)	3 (30%)	40 (66.7%)	0.008*

Table 2: Bivariate analysis for sociodemographic and clinical characteristics variables.
Key: RVD = Retroviral disease.
*Statistically significant.

With regard to sample size and its related risk factors in literature review, the sample of this study is at average rates. It is superior to that of Kumar A [4] in 2010 including 52 participants, 26 in each group (single and double layered); and of Pravin P [5] on a total sample of 50 patients in 2015. It is less than that of Large retrospective analysis of factors relating to leakage of colonic anastomoses reported by Muhammed [2] reported in 2006 and of Sibabrata's report on randomized 95 patients' study in 2017. The sample size depends on the sought risk factors and the clinical situations. It is wished that a bigger sample bring more confidence on statistical analysis.

Determining the prevalence of anastomotic leak in patients undergoing single- and double-layer method

As it was foresaid, the patients with anastomotic leak were 10, translating in 16.7% leak rates. So, 50 had no leak of which 58% were single layered while 42% were double layered. Among the 10 anastomosis which leaked 40% were single and 60% double layered anastomosis as it is shown in figure 2.
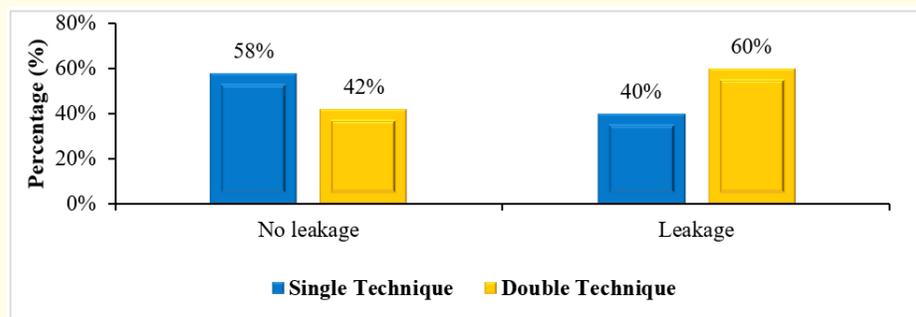

Figure 2: *Prevalence of leakage in patients undergoing one or double layered colic resection.*

The p value in both groups was not significant hence both methods have comparable outcomes.

Identifying factors associated with occurrence of anastomotic leak following single or double-layer large bowel anastomosis

These factors were grouped into four (4), sociodemographic factors (age and gender), past medical history, current diagnosis, and technique of primary anastomosis. The key dependent predictor of failure of anastomosis was a leak. The main question is to know what factor (systemic or local) contributes to colonic wound healing or not.

Almost all situations are detailed on table 2.

Sociodemographic factors

In this study, the independent sociodemographic characteristics were age and gender.

Using bivariate analysis, the outcome which is anastomotic leak for gender was that males were twice more likely to leak compared to females. The age within the inclusion criteria, the mean age in a group without leak was 42.7 years and those with a leak was 41.5 years. The outcome shows insignificant p value for both age group and gender category (See table 2).

This correlate with previous studies from Saravanan in, 2013. Another study in 2015, which is congruous to this study and reported by Pravin P [5] had a total of 50 patients between the age of 18 years and less than 60 years, requiring intestinal anastomosis on emergency or electively, and randomly allocated single layer and double layer groups. Both groups had equal anastomotic leak rate of 6%.

In the similar way, a prospective comparative study was conducted in Madurai and reported by Savaranan in 2013. Cases were allotted to either group alternatively requiring single layer anastomosis (group A) and double layer anastomosis (group B) for various clinical conditions large bowel after fulfilling inclusion and exclusion criteria. Single. All cases were followed up to discharge and subsequently for 2 weeks any complications like leak. The mean age in group A was 41.4 years and in group B was 41.72 years. In group A leak was observed in 1 (4%) and in Group B in 2 (8%) patients. The p value was not significant. One patient in Group B died due to septicaemia and the other two recovered.

However, according to Muhammed [4] in 2006, age beyond 65 years has significant influence on leakage. It may link with comorbidities revealed on history taking.

Past medical history

Past medical history such as hypertension and human immune virus had significant influence.

Those patients with these comorbidities (See table 2) had higher rates of leakages in this study. HIV infection with or without.

This is consistent with other studies whose Selmy [6] in 2021. Other researchers whose Muhammed [2] in 2006 found that factors relating to leakage of colonic anastomoses were correlating with an increased leakage rate were older age, prior radiation therapy, intra-peritoneal infection, and anatomic level of anastomosis.

Current diagnosis

The causes of the resections or reasons for anastomosis are listed on table 2.

Adhesion or bands, Ileo-sigmoid knotting, Gun shots, Colostomy reversal, Colon injury Colorectal cancer and sigmoid volvulus were among the most motifs of anastomosis are listed on table 2 with their frequencies and their p value with regard to the occurrence of leakage. This latter (p value) remain non-significant.

The pre and postoperative diagnosis as well as haematocrit did not have influence of the rates of leakage in this study.

However, serum findings during the hospitalization have some interest as linking to leakage like haematocrit less than 35%, haemoglobin lower than 12 g/dl and Albumin lower than 35 g/L or located between 35 - 60 g/L as it is illustrated in table 2.

Large retrospective analysis of factors relating to leakage of colonic anastomoses found that patients with anaemia had increased leakage rate [2]. It was observed that any unit reduction of albumen, there was a proportion increase in anastomosis leakage significant p value. These results were consistent with results obtained in a study done in Egypt for patients who underwent colorectal anastomosis for any pathology in the period between January 2016 and January 2019 to determine the effect of lower albumen levels. Out of 315 cases, 27 cases (8.57%) developed anastomotic leak after the surgery (leakage group) and the other patients had no leakage (no-leakage group They concluded that preoperative serum albumin level and emergency operations are independent risk factors for anastomotic leakage [6].

The haematocrit of the patient had no effect on anastomotic leak. While albumen and haemoglobin were protective against a leak. Any unit increase in haemoglobin had proportionate reduction in anastomotic leak. Any unit reduction of albumen, there was a proportion increase in anastomosis leakage as shown in table 3.

Variables	Anastomotic Leakage		Linearity p values	p value for ANOVA between groups
	No (Mean ± SD)	Yes (Mean ± SD)		
Age (Years)	42.7 ± 14	41.5 ± 10	0.781	0.802
Albumin (g/L)	38 ± 6.1	33 ± 8.7	0.015	0.031*
Haematocrit (%)	38.7 ± 6.3	34.7 ± 7.5	0.081	0.080
Haemoglobin (g/dl)	12.8 ± 2.3	11.0 ± 2.7	0.023	0.033*

Table 3: Factors associated with anastomotic leakage.

With regard to the albumin as it is illustrated in table 4, the crude and adjusted olds ratios on the logistic regression shows that the olds of an anastomotic leak in either gender and corresponding age group increased by 7.91 and 7 folds with unit decrease in albumen and haemoglobin respectively.

Variables	Unadjusted Logistic Regression		Adjusted Logistic Regression	
	p value	COR (95% CI)	p value	AOR (95% CI)
Haemoglobin cont. (g/dl)	0.041	0.70 (0.50, 0.99)	0.042	0.70 (0.50, 0.99)
Albumin cont. (g/L)	0.039	0.89 (0.80, 0.99)	0.048	0.90 (0.81, 1.00)
Albumin cat. (g/L)				
Less than 35 g/L	0.013	6.64 (1.49, 29.55)	0.018	7.91 (1.44, 46.56)
35 - 60 g/L	Ref			

***Table 4:** Variables.*

Key: AOR = Adjusted odds ratio, cat. = Categories, CI = Confidence Interval, cont. = Continuous, COR = Crude odds ratio. All significant variables were adjusted for age and gender.

Technique of primary anastomosis

50 had no leak of which 58% were single layered while 42% were double layered. The patients who leaked were 10 of which 40% were single and 60% were double layered anastomosis. The p value in both groups was not significant hence, both techniques should have comparable outcomes. These results correspond also with the findings in Madurai study reported in 2013, where among the units put in group A (single layer) leak was observed in 1 (4%) and while in Group B (double layer) leak was observed in 2 (8%) patients. The p value was not significant.

However, contrary results were seen in other studies such as a prospective study of 70 patients who underwent resection and anastomosis in Gujranwala. 10 patients had postoperative anastomotic leak. Out of these 10 patients 7 were of double layer and 3 were of single layer anastomosis. The test of significance revealed significant difference in favour of single layer as reported in 2014 by observed by Liaqat Ali, Zia [7].

Another study with similar results was published in international journal of surgery were no anastomotic leak in group-S (single layer) while one (3.8%) patient in group-D (double layer) suffered from anastomotic leak. It was concluded that single layer anastomosis method is beneficial and safe, and no leak took place after surgery [4].

A meta-analysis of the articles related to single vs double layered anastomoses from 1966-2004 showed that there was no evidence found that two-layer method of intestinal anastomosis leads to fewer postoperative leaks than single layer (Satora S in 2005) but there are trends to believe that single favour is not only because its cost effective but also because what single layer intend to avoid leakage by keeping the mucosa in the lumen allowing it to come and cover the inside of the anastomosis and speed the healing process; Leaving the mucosa not sutured allows also this light layer to keep intact its blood supply as surgeons avoid tension especially when the do reversal of colostomy [8].

Conclusion

This study concluded that patients' demographics and clinical characteristics play a great role in large bowel anastomosis, irrespectively of the method of primary anastomosis with regard to the post-operative leak with or without peritonism. The prevalence of this

complication being very high at the settings the preoperative assessment of these factors and the appropriate intervention would improve outcome of large bowel anastomosis. The single layered extra-mucosal continuous or interrupted intestinal anastomosis reveals being at least equally safe but more cost- effective than conventional double layered technique. Therefore, single layer large bowel anastomosis should be practiced and taught to trainee surgeons simultaneously with the time honeyed double layer technique without prejudice in our settings.

Recommendations

1. The basic principles of suturing remain dogmatic in the colic surgery with regard to its preparation and indication of anastomosis (stumps clean, viable, tension free…)

2. Promote and provide equipment for basic investigations for clinical characteristics such full blood count (haemoglobin) and liver function test (albumen as bare minimum for large bowel primary anastomosis.

3. Develop a fellowship in "surgical suturing" at the level of the department including manual suturing (skin, visceral), mechanic suturing (staplers) laparoscopic suturing.

4. Continue developing scheme for real, access to care especially during emergency.

Bibliography

1. Michael J., *et al*. "Ashley Maingot's Abdominal operations, 19th edition". McGraw-Hill's; 1345-90.

2. Muhammad JR., *et al*. "Use of Single Layer Extra Mucosal Interrupted Suture Intestinal Anastomosis: Three Year Experience". *Journal of Liaquat University of Medical and Health Sciences* 8.1 (2009): 26-28.

3. Nthele M and Odimba BFK. "Early Re-laparotomy at the University teaching Hospital. One year prospective study". Abstract in the proceedings of The Surgical Society of Zambia scientific meeting held at the Ibens Hostel, Zambia (2004).

4. Kumar A and Kumar V. "Single layer versus double layer intestinal anastomoses, A comparative study". *International Surgery Journal* 7.9 (2020): 2991.

5. Pravin P Dandi., *et al*. "A prospective comparative study of intestinal anastomosis, single layer extramucosal versus double layer". *International Journal of Research in Medical Sciences* 3.8 (2015): 2099-2104.

6. Selmy Awad., *et al*. "The assessment of perioperative risk factors of anastomotic leakage after intestinal surgeries; a prospective study". *BMC Surgery* 21.1 (2021): 29.

7. Liaqat A., *et al*. "A Comparative Study on Extramucosal Single Layer versus Double Layer Continuous Intestinal Anastomosis". *PJMHS* 10.2 (2016): 669.

8. Odimba EBFK., *et al*. "Why, When and How to Perform A Manual Colostomy Reversal after A wide Colorectal Resection at Poorly Equipped Surgical Facilities? University Teaching Hospital, Lusaka - Zambia". Book chapter. No.:ˇ2020/BP/5934D, Book name Current Topics in Medicine and Medical Research, Book Publisher International F.No. SDI/BD/5934D/2742 (2020).