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Factors predicting the anastomotic leakage in small bowel anastomoses

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Abstract

Aim: This is a prospective study that studies the various factors predicting the anastomotic leakage in small bowel anastomoses. Patients with suture line disruption were compared with patients whose anastomoses did not leak.

Materials and Methods: All patients above the age of 18 years undergoing surgical closure of a full thickness small intestinal breach, were analyzed and followed up until their discharge from hospital or death.

Type of study: Prospective, analytical study

Place of study: Department of General Surgery, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry

Duration: April 2018 to March 2020

Methodology: Detection of suture line disruption

Result: ASA grade and leak, Biochemical Parameters and leak, Parameters associated with mortality, Anastomotic procedure and leak, Intraoperative factors and leak rate, Typhoid perforations (Widal positive) and leak all the parameters were tabulated conducted to clarify issues relating to factors causing small bowel anastomotic leakage with specific reference to emergency surgeries. Logistic regression and multivariate analysis were used to identify independent predictors of anastomotic leak.

Conclusion: Factors found to have a significant association with suture line disruption by univariate analysis included ASA grade of 3 or above, low hemoglobin, low serum albumin, low preoperative serum sodium, higher mean duration of surgery, presence of gross peritoneal contamination, use of drains in primary anastomoses, higher mean amount of fluids infused intraoperatively, intraoperative hypotension and postoperative ventilatory support.

Keywords: Anastomotic leak, small bowel anastomose, postoperative complications

Introduction

The creation of a joint between the bowel ends in surgery is an important practice for a surgeon. This procedure was often performed by a junior surgeon in the emergency setting. There is a little difference between the outcome of this procedure done by a junior surgeon and done by an established surgeon. To minimize the complications there are few principles which should be adhered during the procedure. For example, the most important thing that should be kept in mind is the presence of excellent blood supply between the bowel edges. The frequency of anastomotic dehiscence was found to be 1–24%. This frequency is high for elective rectal anastomoses than for colonic anastomoses. The postoperative leaks leads to various complications like peritonitis, sepsis, further surgery and the need for stomas. This prospective study studies the various factors predicting the anastomotic leakage in small bowel anastomoses. These includes patient factors like age, nutritional status etc; Intraoperative factors like the duration of surgery, the nature of the disease, usage of fluids etc., and including the experience of the surgeon. Postoperative factors like need for ventilator and vasopressor support etc. In this study mainly focused on to ascertain the contribution of suture line disruption to post operative morbidity and mortality in patients undergoing small intestinal surgery.

Methods and Materials

This prospective, analytical study was conducted in the Department of General Surgery, Sri Venkateshwaraa medical college hospital and research centre, Ariyur, Puducherry between April 2018 to March 2020.

All patients above the age of 18 years undergoing surgical closure of a full thickness small intestinal breach, who satisfied the inclusion criteria, were analyzed and followed up until their discharge from hospital or death.

These patients were ultimately divided into two groups:

- Group 1 – (cases): Patients undergoing small bowel surgery with subsequent suture line disruption.
- Group 2 – (controls): Patients undergoing small bowel surgery without subsequent suture line disruption.

Exclusion criteria

1. Duodenal surgery
2. Anastomoses between the small intestine and stomach or biliary tract.
3. Feeding jejunostomies.
4. Death of the patient within 28 days of admission due to causes other than suture line disruption.

Detection of suture line disruption was based on the following

- Demonstration by relaparotomy.
- Demonstration by dye or contrast studies.
- Efflux of bowel contents from the wound or drain.

Demonstration of any localized collection of bowel contents in the abdominal cavity by ultrasonography guided aspiration.

Methodology

The patients in the study were initially interviewed with specific regard to certain factors known to be of importance in the etiology of disruption. These included age, sex and duration of symptoms before presentation to hospital (in emergency cases). The use of tobacco, alcohol and steroid medications if any was noted, and the presence of Chronic Obstructive Pulmonary Disease (COPD), Diabetes Mellitus, and systemic hypertension was looked for. The attending surgeon's pre-operative diagnosis was also noted down, as per the patient records.

The patient's weights, height, mid arm circumference and triceps skin fold thickness were recorded. Laboratory data obtained in each patient included hemoglobin, serum total protein, albumin, urea, creatinine and electrolytes. Blood was sent for culture and enteric fever serology (Widal) where indicated.

Intra operative variables studied included the presence of gross peritoneal contamination, the nature of the peritoneal contaminant, the site of pathology in the small bowel, the presence, number and size of perforations, the vascular supply at the region of the surgical closure, the luminal disparity between anastomosed ends of bowel, the suture material used, presence of any distal obstruction, and the ease of surgical closure. The amount and nature of intraoperative fluids given the presence of any adverse intraoperative hemodynamic event, the use of drains, the grade of the operating surgeon and the intraoperative diagnosis were also noted.

Post operatively, several factors were taken into account such as use of vasopressor support, ventilatory support, antibiotics used, use of steroids, presence of wound infection, and the time of starting oral fluids.

Patients who had documented suture line disruption and underwent relaparotomy for the same were taken as fresh cases, and data recorded again as above.

Patients who had suture line disruption (test) were compared with patients whose anastomoses did not leak (control). Statistical analysis was done using Fisher's exact test and chi square test for discrete variables and the student's t-test for continuous data. The Statistical Package for Social Sciences (SPSS) software version 10.0 was utilized. A p value <0.05 was considered significant for the purpose of this study.

Results

Table 1: ASA grade and leak

ASA grade	Leak		Total
	Present	Absent	
ASA grade equal to or more than 3	19	19	38
ASA grade less than 3	13	32	45
Total	32	51	83

P=0.049

Table 2: Biochemical Parameters and leak

Variables	Leak		p value
	Present	Absent	
Hemoglobin (g/dL)	9.509 ± 1.941	10.478 ± 1.967	0.031*
Serum total protein (g/dL)	5.391 ± 1.242	5.808 ± 1.094	0.112
Serum albumin (g/dL)	2.772 ± 0.450	3.149 ± 0.609	0.003*
Urea (mg/dL)	50.34 ± 39.00	47.53 ± 34.58	0.732
Creatinine (mg/dL)	0.86 ± 0.386	0.805 ± 0.630	0.991
Sodium (meq/L)	131.09 ± 6.32	135.63 ± 7.51	0.006*
Potassium (meq/L)	3.912 ± 0.653	4.105 ± 0.530	0.146

Table 3: Indications for surgery and leak

Post-op diagnosis	Leak		Total
	Present	Absent	
Perforation	13	15	28
Gangrene gut	5	11	16
Intestinal obstruction	9	24	33
Reanastomosis for leak	5	01	06
Total	32	51	83

P= 0.047

Table 4: Typhoid perforations (Widal positive) and leak

Enteric Perforations	Leak		Total
	Present	Absent	
Typhoid	3	4	7
Non typhoid	8	7	15
Total	11	11	22

P= 1.000

Table 5: Intraoperative factors and leak rate

Variables	Leak		P value
	Present (n = 32)	Absent (n = 51)	
Mean duration of surgery (mins)	158.91 ± 62.70	133.53 ± 51.37	0.048*
Presence of gross peritoneal contamination	24/32	25/51	0.023#
Patients with multiple perforations (n = 12)	7/12	5/12	0.731
Mean distance from ileocaecal junction in distal small bowel anastomoses (cms)	37.35 ± 26.86	45.49 ± 33.38	0.322
Mean distance from duodenojejunal flexure in proximal small bowel anastomoses (cms)	37 ± 26.6	38.33 ± 33.04	0.936
Suture material used (inner absorbable and outer non absorbable)	26/32	41/51	0.9
Total fluid infused (ml)	2908.44±1272.50	2368.63±1024.84	0.037
Presence of Intraoperative hypotension	8/32	1/51	0.001
Use of drains (primary anastomoses group)	21/24	30/49	0.029
Cases operated by junior residents	10/32	17/51	1.000

Table 6: Postoperative factors and leak

Variables	Leak		p value
	Present	Absent	
Ventilatory support	10/32	5/51	0.019*
Vasopressor support	8/32	5/51	0.118
Time of starting oral intake (hours)	127.89 ± 41.19	115.1 ± 28.97	0.153

Table 7: Anastomotic procedure and leak

Anastomosis	Leak		Total
	Present	Absent	
Small to small bowel	23	45	68
Small to large bowel	9	6	15
Total	32	51	83

Table 8: Parameters associated with mortality

Variable	Dead (n =13)	Alive (n=60)	p-value
Serum albumin (gm %)	2.715 ± 0.486	3.117 ± 0.576	0.022*
Duration of surgery (minutes)	165.00 ± 56.12	130.50 ± 45.15	0.02*
ASA grade equal or above 3	11/13	24/60	0.00#
Intraoperative hypotension	5/13	3/60	0.004#
Ventilatory support	5/13	5/60	0.013#
Reanastomosis for leak	4/1	2/60	0.008#
Small to large bowel anastomoses	6/13	6/60	0.005#

Table 9: Multiple logistic regression for suture line disruption

Variable	B	Standard error	p value	Exp (B) or Odd's ratio
Albumin	1.587	0.554	0.004*	4.901
Sodium	0.134	0.047	0.004*	1.144
Peritoneal contamination	1.422	0.636	0.025*	4.147
Intraoperative hypotension	2.3	1.141	0.044*	9.977
Constant	20.958	6.828	0.002	

Z = Probability of suture line disruption
= 20.958 + (1.587) Albumin + (0.134) Sodium + (1.422) Peritonitis + (2.3) Intraoperative hypotension)

Discussion

The construction of anastomoses is fraught with potential problems for the surgeon, who realizes that anything short of meticulous attention to it can have devastating consequences. However it is seen that anastomotic disruptions occur frequently despite the greatest attentions to technical detail. This has stimulated many workers to search for other causative factors that although not readily apparent, may be amenable for correction in the perioperative period, thus lessening the incidence of the problem.

This prospective study having 73 patients with 83 anastomoses between them. Most of the existing work on this subject has been in the form of retrospective studies and have focused on multiple levels of the gastrointestinal tract, rather than a specific part. No studies have so far dealt with the risk factors per se involved in small bowel suture line disruption.

Our present effort was conducted to clarify issues relating to factors causing small bowel anastomotic leakage with specific reference to emergency surgeries, as the majority of cases (96.3%) we analyzed were emergencies. We utilized logistic regression and multivariate analysis to identify independent

predictors of anastomotic leak.

The mean age of the subjects in our series was 38.02 ± 16.26 years. Other studies [1] have reported higher mean ages, but none have conclusively stated that advanced age is a risk factor for suture line leak. Hesp and co-workers [7] subdivided the small bowel anastomoses into 4 groups based on etiology. Those patients forming the "inflammatory" group of intra-abdominal infections and inflammatory bowel disease had a mean age of 41 years, which compares well with our series. "Vascular" cases comprised mainly by strangulated hernias and mesenteric vascular occlusions had a higher mean age of 53 years. Stoop and co-workers [8] found from their animal studies that advanced age is not an independent risk factor for the breakdown of intestinal anastomoses. The lower mean ages we encountered could be due to the higher prevalence of specific and non-specific small bowel perforations in our series, which is usually seen to affect individuals in the prime of their lives. This sub group formed 33.7% of our cases, and the mean age observed was 33.07±14.32 years. Chaikof *et al.* [11] noted a mean age of 51.8±21.8 years in his work on non-traumatic small bowel perforations, which pertained mainly to non-infective causes. Other studies [12, 13] on typhoid enteric perforations have also yielded similar results.

45 males (61.6%) and 28 female patients (38.4%) constituted our study group. No significant association with leakage was noted in either group. Golub *et al.* [1] made similar observations, noting no gender association for leakage.

Fawcett and colleagues [9] noted that smoking and hypertension were significantly associated with the occurrence of suture line disruption in colonic anastomoses. This was attributed to the increased incidence of microvascular disease in the anastomotic region caused by these risk factors. It is unclear to us whether such factors affect small bowel vascularity too; our sample size

did not allow us to make any relevant conclusions in this regard. Pickleman *et al.* [6] also found that hypertension was a risk factor in the development of small intestinal anastomotic leakage. Diabetes has been shown in many studies not to have a significant association with disruption [6, 9] COPD was noted to be an independent predictor of leakage in one study [1].

No significant association between baseline hemodynamic measurements at admission in emergency cases and the occurrence of leak or death was noted in our study. As most of the existing literature focuses on a rather uniformly mixed patient population of elective and emergency cases, related observations were lacking in them.

The implications of malnutrition on anastomotic healing have been well established in previous studies. We found that anthropometric variables possessed no reliability in predicting leaks. That the former is not of use in the assessment of protein malnutrition was already shown by Collins and associates [2] in their study.

A low serum albumin was noted to be predictive of anastomotic disruption in our series ($p=0.003$). Our findings corroborate the conclusions of other workers who noted the association between hypoalbuminemia and deranged wound healing [4, 5].

The pre-operative serum sodium was also shown in our study to have an association with anastomotic leakage ($p=0.006$). The mean sodium level in the leak group was significantly lower than in controls. Our explanation for this finding is the possible occurrence of anastomotic oedema in the hyponatremic state, which is known to have adverse effects on intestinal suture lines. The detrimental effects of acute uremia on anastomotic healing were exhibited by Colin *et al.* [10] in their animal study. They noted that bursting pressures of midline abdominal incisions and small intestinal anastomoses were reduced by the uremic state. The degree of fibroblastic growth and cellular proliferation was severely affected by high serum urea levels. None of our patients had established acute renal failure, although pre renal azotemia was noted in some. The mean urea levels between the leak and control groups in our study were comparable.

An ASA grade of 3 or more was associated with increased risk of leakage ($p=0.049$). Golu [1], Alves [3] and co-workers reported the association of increasing ASA grade with anastomotic complications.

The patients in our study were grouped into 4 main categories based on intraoperative findings *viz.*, small bowel perforation, intestinal obstruction, gangrene gut and those undergoing reanastomosis for anastomotic leakage. Except for this last group ($p=0.030$), none of the groups had a statistical association with the occurrence of leak. Some studies have underlined the importance of intestinal obstruction as a determinant of suture line disruption [1] although we were not able to arrive at similar conclusions.

Widal serology in association with spontaneous small bowel perforations was used in our study for the purpose of diagnosing Typhoid fever. We noted 7 cases of typhoid perforation, the other 15 in whom the test was negative being assigned to the group of non-specific enteric perforations.

We noted that the mean duration of surgery in the leak group was significantly higher than in the control group ($p=0.048$). This is most probably reflective of the difficulties faced intraoperatively which might later predispose to leakage.

We found that the presence of peritoneal contamination had an association with the occurrence of anastomotic leakage ($p=0.023$).

The level of anastomotic construction had no bearing on the incidence of leak in our study. Hesp and co-workers [7] remarked that jejunojunal anastomoses were less prone to leakage that

those constructed distally, but no significant differences were observed in this regard in their study. Golu [1], Pickleman [6] and colleagues had reported that they found no differences between end to end, end to side or side to side anastomoses in their studies. Alves *et al.* [3] reported colocolic anastomoses as having a significant risk of leakage, but a comparison was not within the scope of our study.

We analyzed the effects of intraoperative transfusion and found no relation between it and the occurrence of suture line disruption ($p=0.25$). The total fluid infused in the intraoperative period did however have a statistical association with the incidence of anastomotic dehiscence ($p=0.037$).

The usage of intra-abdominal drains for patients undergoing primary anastomoses was found to have an association with suture line leak in our study ($p=0.029$).

Our analysis revealed that mechanical ventilatory support in the post-operative period was associated with anastomotic dehiscence ($p=0.019$). Tissue hypoperfusion and decreased oxygen tension at the anastomotic level are known to adversely affect its healing. Golu and colleagues mentioned COPD as a predictor of leakage, and stated that the low tissue oxygen levels seen in COPD might be the causative factor of dehiscence. We feel that the use of post-operative ventilatory support could be a post-operative indicator of poor tissue oxygenation and hence its association with disruption. A significant association between the use of vasopressor support and leakage could not be demonstrated ($p=0.118$) in spite of the fact that vasopressor agents are known to compromise mesenteric blood flow, thus perhaps affecting anastomotic healing.

In the patients who died, all of whom belonged to the suture line disruption group, no significant difference was observed between those who were managed conservatively and those who had a surgical exteriorization of the leak site ($p=1.00$). Reanastomosis after an anastomotic leak was shown to have a significant association with mortality ($p=0.041$), 8 out of the 10 patients it was performed in having died. We strongly recommend that small bowel suture line disruption should be treated by exteriorization of the leak site whenever relaparotomy is done for the same.

The overall mortality rate in our study was 17.7% (13/73 deaths). All the deaths occurred in the leak group. The mortality rate in the leak group was 52% (13/25 deaths). Hesp *et al.* [7] noted deaths in 18% of their patients who sustained small bowel anastomotic leakage.

There was no association noted between age and mortality in our series. Several investigators have established age as a predictor of mortality in small bowel perforations [9] but this sub group in our series also did not have any significant association with the risk of death.

Low serum albumin levels were significantly associated with increased mortality ($p=0.022$), as was an ASA grade of 3 and above ($p=0.005$).

The duration of surgery differed significantly between survivors and non survivors ($p=0.02$). This difference persisted even when considering just those who underwent primary anastomoses. Other study did not find such an association [1].

Intraoperative hypotension was shown to have a significant association with mortality ($p=0.004$). Ventilatory support was also shown to be significantly associated with the incidence of mortality ($p=0.013$) while vasopressor usage had no such relation. The relative contributions of these factors to anastomotic morbidity or mortality have not been noted before, to our knowledge. Small to large bowel anastomoses were found to have a significant association with mortality in our study.

Conclusion

Factors found to have a significant association with suture line disruption by univariate analysis included ASA grade of 3 or above, low hemoglobin, low serum albumin, low preoperative serum sodium, higher mean duration of surgery, presence of gross peritoneal contamination, use of drains in primary anastomoses, higher mean amount of fluids infused intraoperatively, intraoperative hypotension and post-operative ventilatory support. Multivariate analysis using binary logistic regression revealed that hypoalbuminemia, low preoperative serum sodium levels, presence of gross peritoneal contamination and intraoperative hypotension were all predictive of suture line disruption.

Reanastomosis after anastomotic leak was shown to be significantly associated with leakage, and with mortality. So small bowel suture line disruption should be treated by exteriorization of the leak site whenever relaparotomy is done for the same. Factors associated with mortality included low serum albumin, increasing duration of surgery, ASA grade of 3 or above, intraoperative hypotension, post-operative ventilatory support, reanastomosis for leak and small to large bowel anastomoses.

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