Original article

Factors predicting stomal wound closure infection rates

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Received 2 February 2012 / **Accepted** 22 April 2012

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Abstract

Background Stoma closure is associated with high wound infection rates. The aim of this study was to evaluate risk factors for infection rates in such wounds, with particular emphasis on assessing the importance of the stomal wound closure technique. **Methods** A retrospective analysis of 142 patients who had undergone ileostomy or colostomy closure between 2002-2011 was performed. Postoperative outcome as measured by wound infection rate was recorded. Three different closure techniques were identified: Primary closure (PC), primary closure with Penrose drain

(PCP) and pursestring circumferential wound approximation technique (PSC). Other factors such as age, sex, ASA score, type of prophylactic antibiotics used, diabetes, smoking and obesity were also analyzed. All other techniques were excluded. **Results** Our series consisted of 142 stomal closures (90 ileostomy and 52 colostomy closures). The patients had a median age of 63.5 years with an interquartile range of 50.1-73.2 years. The overall wound infection rate was 10.7%. PC, PCP, and PSC were associated with wound infection rates of 17.9%, 10.5% and 3.6% respectively. Compared to PSC, PC and PCP were associated with significantly higher wound infection rates (p=0.027and p=0.068 respectively). Obesity was a significant risk factor for wound infection (p = 0.024). Use of triple agent antibiotics prophylactically had a protective effect on the infection rate (p= 0.012). **Conclusions** To reduce stomal wound closure infection rates, we recommend institution of closure techniques other than PC with or without a drain. Risk factors such as obesity should be addressed and prophylactic triple antibiotics should be administered.

Key words: Stoma; Surgical site wound infection; Surgical technique

Introduction

Loop ileostomies are now commonly created as part of sphincter-saving low rectal cancer surgery in order to reduce morbidity associated with pelvic anastomotic leakage [1, 2]. Similarly end colostomies are still created as part of Hartmann's procedure for complicated diverticular disease, particularly in high risk patients [3, 4]. The creation of such stomas is meant to have a protective effect in situations where distal anastomoses are precarious. However, stomal closures can be associated with significant morbidity, the most common of which is wound infection, a testament to

the contaminated nature of this procedure. Given the elective nature of stoma closures in patients who may be otherwise well and the fact that in some cases closure is indicated purely for convenience, minimising morbidity should be the top priority. In this study we aim to identify the risk factors for stomal closure wound infection , in particular assessing the importance of stomal wound closure techniques.

Materials and methods

The study population consisted of 142 patients who had undergone closure of loop ileostomy or colostomy at the colorectal unit across two health networks (Frankston 2003-09, Southern Health 2010-11). Data was collected from the patients' medical records. Charts were reviewed for demographic data, obesity body mass index (BMI)>30 kg/m_2, presence of diabetes, smoking status, time interval between stoma creation and closure, prophylactic and type of antibiotics used, American Society of Anaesthesiology (ASA) score, type of stoma closed, primary pathology, closure technique employed and wound infection rate. Patients who underwent stoma closure with a technique other than PCP, PC and PSC were excluded (n=15).

Wound infection was defined as presence of cellulitis or purulent discharge with or without positive bacterial growth within 30 days of surgery (adopted from the 1992 Center for Disease Control (CDC) definition of surgical site wound infection [5]). Whilst inpatient wounds were observed on a daily basis by the surgical team, follow-up included outpatient notes and readmission to hospital.

Operative technique

The technique employed was at the discretion of the operating surgeon. Mechanical bowel preparation was used only in patients with a colostomy. On induction, prophylactic antibiotics were administered to most patients and no antibiotics were given postoperatively. Three closure techniques were employed; primary closure (PC), primary closure with Penrose drain (PCP) and purse-string circumferential wound approximation technique (PSC). These methods only differed in the way the skin was closed and whether a drain was inserted. All closures of the stoma involved mobilization, some form of anastomosis and repair of the rectus sheath with either continuous or interrupted non-absorbable sutures.

In PC, the skin was closed with interrupted non-absorable sutures. In PCP, the wound was closed with non-absorable sutures after inserting a Penrose drain in the subcutaneous cavity. The drain was then fixed with a suture or safety pin at the end of the wound (Figure 1). A Penrose drain is a soft tube-shaped silicone drain and serves to minimize dead space after surgical closure and to drain fluid. All Penrose drains were left in place for 3-5 days, so that a tract was formed promoting continual drainage.

The PSC method involved apposing the skin edges with a subcuticular absorbable suture in a circumferential manner. The purse-string was then drawn together leaving a small circular defect which was left open for free drainage, granulation and epithelialization (Figure 2). If the wound was not tension- free, then the skin edge was undermined prior to closing.

Non-absorable skin sutures were routinely removed 10-14 days after surgery or earlier if indicated by signs of wound sepsis.

Statistical analysis

For continuous variables, differences in medians were calculated using the Wilcoxon rank sum test (when comparing 2 groups) and the Kruskal-Wallis test (when comparing more than two groups). Categorical variables were compared using the Fisher exact test. A multivariate logit model was used to examine the factors that increased the likelihood of a wound infection. Regression analysis was performed using Eviews v5.0. A p-value < 0.05 was considered statistically significant.

Results

The patient population comprised 90 males and 52 females with a median age of 63.5 years and an interquartile range (IQR) of 50.1-73.2 years (Table 1). The median American Society of Anesthesiologists (ASA) score was 2. The ASA scores of 3 patients were unknown. About 16% were active smokers, 10% diabetic and 9% morbidly obese.

The stoma closures consisted of 90 (63%) reversals of ileostomies and 52 (37%) reversals of colostomies (Table 1). The most common indication for ileostomy construction was a diverting loop stoma for rectal cancer surgery. The most common indication for creation of end colostomy was complicated diverticular disease . The median time to closure was 46.1 weeks. The most common closure technique employed was PCP (61%). PC and PSC were performed in 20% of cases each. Prophylactic intravenous antibiotic were administered to 134 patients, whilst 8 patients received no antibiotics. The antibiotic regimen most commonly used was a

combination of amoxicillin (or cefazolin), gentamicin and metronidazole (triple antibiotic). The second most commonly used was cefazolin/ceftriaxone and Metronidazole (dual agent).

Postoperative complications are listed in table 1. There was one death due to pulmonary embolism.

The overall wound infection rate was 10.5%, 15/142 (Table 2). PC and PCP were associated with the highest wound infection rate, 17.9% (5/28) and 10.5% (9/86) respectively. PSC was associated with a wound infection rate of 3.6% (1/28). All patients responded to antibiotics with or without open drainage of the wound.

Table 3 examines the differences between the groups of patients with or without postoperative stomal wound infection (bivariate analysis). The results in table 3 indicate that there is no clinically significant difference between the two groups with respect to their demographics , risk factors and postoperative length of stay. The risk factors are further analyzed in multivariate regression analysis below.

Table 3 presents the results from the estimated multivariate model, where all the statistically insignificant variables have been removed. The results indicate that after controlling for other factors, the PSC closure technique has the lowest probability of experiencing a wound infection. The PC (OR=18.7, 95% CI 1.4-252.0, p= 0.027) and PCP (OR=10.2, 95% CI 0.8-124.9, p=0.068) closure techniques are associated with a higher probability of wound infection. Closure of ileostomy may result in a lower

probability of wound infection than colostomy but the p-value was not significant (odds ratio (OR)= 0.3, 95%, confidence interval (CI) 0.08-1.06, p= 0.061). Morbidly obese patients are more likely to experience a wound infection (OR=7.6, 95% CI 1.3-44.6, p =0.024). Relative to the use of triple antibiotic therapy , we found the use of only two antibiotics increased the likelihood of a wound infection (OR= 5.3, 95% CI 1.4-19.6, p= 0.012). Age, sex, time to closure and ASA score were not found to be clinically significant risk factors predicting the wound infection rate.

Table 4 shows a subgroup analysis of the patients' clinical features for each closure technique. The results indicate that there were no statistically significant differences in the demographics for patients in each closure technique group.

Table 5 explores the distribution of infection rate and technique according to procedure type. No statistically significant difference was noted in the infection rate between the two procedure types.

Discussion

Wound infection rates after stoma closure as reported in the English literature vary from 0-40% [6-15]. Wound infection and small bowel obstruction are among the two most common complications after stomal wound closure [7-10]. Our study showed an overall wound infection rate of 10.6%, comparable to if not better than that reported in the literature. Methods for reducing morbidity associated with stomal closure not only minimize the physiological and psychological toll on the patient but also reduce

the postoperative cost. In this study we identified certain modifiable factors that may reduce the stomal wound infection rate.

Several stomal closure techniques have been described in the literature, including PC, delayed PC, secondary closure and PSC. The PSC wound approximation method was reported in the literature in 1997 though many colorectal surgeons had previously been using this technique [16]. PSC closure has also been described in dermatological surgery where it is used for closure of small skin defects or as partial closure of larger round wounds after skin cancer excision [17]. The literature has supported its use for stomal wound closure since it is simple and has been shown to be associated with a lower wound infection rate with better cosmetic results than other techniques [6, 12, 17]. Given that the wound is partially left open, PSC also adheres to the surgical adage that contaminated wounds should not be closed. Infection rates associated with using this type of stomal closure have been reported to be 0% by Milanchi et al, Marquez et al and Sutton et al [6, 12, 18]. Our study demonstrated an infection rate of 3.6% associated with this method, which is much better than that associated with PC or PCP.

PC has one of the highest wound infection rates, up to 36-40% [6, 13]. However, some authors suggest that it may be better than delayed closure [11, 19]. The obvious advantage of PC is the simpler postoperative wound care. PC in our study was associated with the highest wound infection rate (18%), similar to that reported by Marquez et al [18]. Thus it is clear that methods other than PC are preferable in order to minimize wound sepsis.

There is a paucity of data in the literature on the use of drains for stomal wounds. At our institution the Penrose drain is most commonly used. The relatively high wound infection rate associated with the use of the PCP method was unexpected. Despite the infection rate of 10% associated with PCP method, such a result may be an acceptable outcome for some surgeons. On multivariate analysis, our study did show a significantly improved outcome with respect to infection when the PSC method was used compared to PC or PCP. No significant biases were identified on subgroup analysis of patient's clinical features for each group.

Our study also analysed other risk factors that may increase the wound infection rate. Morbid obesity was associated with a significantly increased risk of infection ($p=0.024$). In multivariate analysis a negative association was noted with ileostomy closure but with a nonsignificant p -value. Further group analysis failed to show any difference in wound infection according to stoma type. Studies have shown ileostomy closure to be associated with higher morbidity [1, 13]. Other factors such as age, sex, ASA score, presence of diabetes and time to closure were not found to be clinically significant risk factors.

Time to closure has been shown to be important in reducing skin complications after stoma closure. Perez et al [8], analyzing outcome post closure of loop ileostomy suggested that complications were lower if the ileostomy was closed no less than 8.5 weeks ($p<0.05$). This is also suggested by other studies [9, 14]. Keck et al similarly recommended a delay of 15 weeks when reversal of Hartmann's is considered [4]. In this study, time to closure was not a significant variable for wound infection. We used multiple antibiotic regimens in our series. The most common was the triple antibiotic

regimen. Our statistical analysis revealed a much higher incidence of wound infection when an antibiotic regimen other than triple was used prophylactically ($p=0.012$). This is due to the polymicrobial nature of stomal wound infections and shows the importance of covering Gram- positive bacteria including enterococcus with amoxicillin, Gram- negative bacteria with gentamicin and anaerobes with metronidazole.

Our study was limited by being a retrospective study with a relatively biased sample size with respect to each closure technique, thus a type II error may have occurred. Furthermore, patients were only followed up to 14 days. However, given that our institution is the only hospital in the area with an emergency department or a surgical outpatient clinic, we would expect that most patients would return to our hospital with any postoperative issue. This study, however, calls for a randomized trial of patients for each closure technique by the same surgical team, with each group being matched for age, sex, procedure type and co-morbidity.

When one considers an optimal skin closure technique, factors other than infection rate should also be considered. The time to wound closure will no doubt be longer in PSC as the wound is left partially open, and the impact of this will vary from patient to patient. This should be balanced against the morbidity associated with wound sepsis. It should also be noted that surgical technique is not only important in the closure of a stoma but also in the creation of a stoma [20].

Conclusions

Based on this study, methods of reducing the infection rate associated with closure of stomas include the use of techniques other than primary closure, with or without a

subcutaneous drain. Preoperative factors to consider include use of prophylactic triple antibiotics and optimizing the patient's co-morbidities including addressing obesity.

Acknowledgments: We would like to thank Dr Zahrul Ismadi for his assistance with data collection.

Conflict of interest: None

References

1. Gastinger I, Marusch F, Steinert R, Wolff S, Koekerling F, Lipport H (2005) Protective defunctioning stoma in low anterior resection for rectal carcinoma. Br J Surg 92:1137-1142
2. Tan WS, Tang CL, Shi L, Eu KW (2009) Meta-analysis of defunctioning stoma in low anterior resection for rectal cancer. Br J Surg 96:462-472
3. Oomen JL, Cuesta MA , Engel AF (2005) Reversal of Hartmann's procedure after surgery for complications of diverticular disease of the sigmoid colon is safe and possible in most patients. Dig Surg 22:419-425
4. Keck JO, Collopy BT, Ryan PJ, Fink R, Mackay JR, Woods RJ (1994) Reversal of Hartmann's procedure: effect of timing and technique on ease and safety. Dis Colon Rectum 37:243-248
5. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG (1992) CDC definition of nosocomial surgical site infection, 1992: A modification of CDC definition of surgical wound infection. Infect Control Hosp Epidemiol 13:606-608

6. Milanchi S, Nasseri Y, Kidner T, Fleshner P (2009) Wound Infection after ileostomy closure can be eliminated by circumferential subcuticular wound approximation. Dis Colon Rectum 52:469-474
7. Williams LA, Sagar PM, Finan PJ, Burke D (2008) The outcome of loop ileostomy closure: a prospective study. Colorectal Dis 10:460-464
8. Perez RO, Habr-Gama A, Seid VE et al (2006) Loop ileostomy morbidity: timing of closure matters. Dis Colon Rectum 49:1539-1545
9. Mann LJ, Stewart PJ, Goodwin RJ, Chapus PH, Bokey EL (1991) Complications following closure of loop ileostomy. ANZ J Surg 61:493-496
10. Phang PT, Hain JM, Perez-Ramirez JJ, Madoff RD, Gernio BT (1999) Techniques and complications of ileostomy takedown. Am J Surg 177:463-466
11. Lahat G, Tulchinsky H, Goldman G, Klauzner JM, Rabau M (2005) Wound infection after ileostomy closure: a prospective randomized study comparing primary vs. delayed primary closure technique. Tech Coloproctol 9:206-208
12. Sutton CD, Williams N, Marshall L, Lloyd G, Thomas WM (2002) A Technique for wound closure that minimizes sepsis after stoma closure. ANZ J Surg 72:766-767
13. Vermulst N, Vermeulen J, Hazebroek EJ, Coene PP, Van der Harst E (2006) Primary closure of the skin after stoma closure. Dig Surg 23:255-258
14. Wong KS, Remzi FH, Gorgun E et al (2005) Loop ileostomy closure after restorative proctocolectomy: outcome in 1,504 patients. Dis Colon Rectum 48:243-250

15. Bell C, Asolati M, Hamilton E et al (2005) A comparison of complications associated with colostomy reversal versus ileostomy reversal. Am J Surg 190:717-720
16. Banerjee A (1997) Pursestring skin closure after stoma reversal. Dis Colon Rectum 40:993-994
17. Cohen PR, Martinelli PT, Schulze KE, Nelson BR (2007) The cuticular purse string suture: a modified purse string suture for the partial closure of round postoperative wounds. Int J Dermatol 46:746-753
18. Marquez TT, Christoforidis D, Abraham A, Madoff RD, Rothenberger DA (2010) Wound Infection Following Stoma Takedown : Primary Skin Closure versus Subcuticular Purse-string Suture. World J Surg 34:2877-2882
19. Harold DM, Johnson EK, Rizzo JA, Steele SR (2010) Primary Closure of stoma site wound after ostomy takedown. Am J Surg 199:621-624
20. Keating J, Kelly EW, Hunt I (2003) Save the skin and improve the scar. A simple technique to minimize the scar from a temporary stoma. Dis Colon Rectum 46:1428-1429

Table 1 Patient and Operation Demographics

Patient Demographic		Number of Patients
Age (years)	Median	63.5
	IQR	50.1-73.2
Sex	Male	90
	Female	52
ASA score	Median	2
	1	15
	2	78
	3	42
	4	3
Active Smoker		23
Diabetes		14
Obesity		12
Surgery Data		
Reversal of ileostomy		90
Reversal of colostomy		52
Time to closure (weeks)	Median	46.14
Closure technique	PCP	86
	PC	28
	PSC	28
Antibiotics used	None	5
	Triple Agent	48
	Dual agent	60
	Others	29
Length of stay	Median	6 days
	Mean	7.8 days
Postoperative complications (%)		
	Stomal wound infection	15 (10.5)
	Laparotomy wound infection (only in colostomy group)	3(5.7)
	Ileus	13(9.1)
	Pneumonia	5(3.5)
	Anastomotic leak	2(1.4)
	Death	1(0.70)

Table 2 Differences between patients with or without postoperative stomal wound infection

	INFECTION Number (%)	NO INFECTION Number (%)	P- VALUE
Sample	15	127	
Median age (years)	58.6	64.4	0.376
Male	10(66.7)	80(63.0)	1.00
Female	5(33.3)	47 (37.0)	
Median time to closure (weeks)	45.9	46.3	0.348
ASA score (median)	2	2	n/a
ASA 1	3(20.0)	12(10.8)	0.481
ASA 2	9(60.0)	69(54.3)	
ASA 3	3(20.0)	39(30.7)	
ASA 4	0	2(1.6)	
Active smoker	3(20.0)	20(15.7)	0.711
Diabetes	1(6.7)	13(10.2)	1.00
Obesity	3(20.0)	9(7.0)	0.117
Ileostomy closure	8(53.3)	82(64.6)	0.408
Colostomy closure	7(46.7)	45(35.4)	
Closure Technique			
-PC	5(33.3)	23(18.1)	0.227
-PCP	9(60.0)	77(60.1)	
-PSC	1(6.7)	27(21.0)	
Prophylactic Antibiotic Used			
- Triple agent	2(13.3)	44(34.6)	0.140
- Dual agent	13(86.7)	74(58.3)	
- Other	0	8(6.3)	
Length of stay (mean) days	8.6	7.0	0.086

Table 3 Factors affecting the probability of wound infection

Variable	Coefficient	Odds Ratio (95% Confidence interval)	p value
PC*	2.92	18.7 (1.4-252.0)	0.027
PCP*	2.33	10.2 (0.8-124.9)	0.068
Procedure (ileostomy closure)	-1.21	0.3 (0.08-1.06)	0.061
Morbid obesity	2.03	7.6 (1.3-44.6)	0.024
Dual agent antibiotic regimen #	1.67	5.3(1.4-19.6)	0.012

* The coefficient measures the effect relative to the PSC closure technique.

The coefficient measures the effect relative to the triple agent regimen

Note the negative co-efficient suggests the presence of this factor will result in lower risk of wound infection

Table 4 Patients' clinical features listed according to closure technique used

Demographic	Closure technique			P value
	PCP	PC	PSC	
Number	86	28	28	
Median age (years)	60.8	67.3	61.5	0.203
Sex – Male	54	16	20	0.554
- Female	32	12	8	
ASA –(average)	2.1	2.3	2.3	0.160
Active smoker (%)	16	3	4	0.662
Diabetes (%)	5	5	4	0.119
Morbid obesity (%)	4	3	5	0.062

Table 5 Closure technique and infection rate listed according to the procedure type

	Procedure Type		P value
	Ileostomy	Colostomy	
Number	90	52	
Wound infection	8	7	0.408
Skin closure technique (number with wound infection)			
- PCP	57(3)	29(6)	0.056
- PC	18(5)	10(0)	0.128
- PSC	15(0)	13(1)	0.464

Figure legends

Figure 1 Primary closure with Penrose drain (PCP).

Figure 2 Purse-string circumferential wound closure (PSC).