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Risk factors for surgical site infection after stoma closure comparison between pursestring wound closure and conventional linear wound closure: Propensity score matching analysis

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ABSTRACT

Purpose: Stoma closure has been associated with a high rate of surgical site infection (SSI) and the optimal skin closure method is still controversial. The aim of this study was to compare the short-term and long-term outcomes between the conventional linear closure (CC) and the persestring closure (PC) using propensity score matching analysis.
Methods: We analysed the data of 360 patients who underwent stoma closure with CC or PC between January 2000 and December 2014. The propensity score was calculated from age, gender, body mass index, primary disease, type of stoma, diabetes mellitus, history of smoking, steroid use, the American Society of Anesthesiologists score, Prognostic Nutritional Index and modified Glasgow Prognostic Score.
Results: There was no difference in operative variables between the two groups. The CC group and the PC group were comparable with regards to overall SSI (25.0 vs. 7.8%; $P = 0.007$), superficial SSI (21.9 vs. 4.7%; $P = 0.003$). Significant risk factor for SSI was conventional linear closure (OR, 4.14; 95% CI, 1.448−13.91).
Conclusion: Our study suggests that a pursestring stoma closure leads to less SSI.

1. Introduction

Currently, the use of temporary diverting stoma has increased in low colorectal or coloanal anastomosis in order to reduce anastomotic complications.[1] However, stoma closure is associated with mortality and complications, such as surgical site infection (SSI), anastomotic leakage, bleeding or ileus.[2,3] SSI is one of the most common complications, with a reported rate of incidence ranging from 3 to 43%.[4–6] SSI following stoma closure increases the risk of the length of hospital stay, more frequent outpatient follow-up and wound incisional hernia.[7,8] Banarjee reported a wound closure method with subcutaneous pursestring suture.[9] Several randomized controlled trials demonstrated better cosmetic result and lower SSI rate than conventional linear closure.[10–12] A recent meta-analysis confirmed that pursestring skin closure had a significant decrease in SSI and higher satisfaction with cosmetic outcomes.[13] However, there were few reports that describe the long-term follow-up, such as incisional hernia associated with this management strategy. Furthermore, the presence of an elevated Systemic Inflammatory Response (SIR) as evidenced by an alteration in circulating acute phase proteins were associated with poor outcomes in colorectal surgery in several reports.[14] The preoperative SIR such as C-reactive protein (CRP), modified Glasgow Prognostic Score (mGPS) and Prognostic Nutritional Index (PNI) have been shown to be predictive of a postoperative infection.[15–17]

The aim of this study was to compare the short-term and long-term outcomes between the conventional linear closure and the pursestring closure using propensity score matching (PSM) analysis.

2. Methods

2.1. Patients

From January 2000 to December 2014, all consecutive a total of 360 patients underwent surgery for stoma closure in our institution. Patients were divided into two groups according to the

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operative management. During the nine years, all skin wounds were closed by conventional linear closure (CC). Over the next five years, all skin wounds underwent pursestring closure (PC). In order to minimise differences that might be attributable to skin preparation, antibiotic prophylaxis, surgical technique or wound closure, the standard procedures were followed in all patients. Nutritional assessment were evaluated according to PNI and mGPS. The PNI was calculated using following formula: 10 × serum albumin concentration (g/dl) + 0.005 × total lymphocyte count (number/ml) in the peripheral blood. The cutoff value for the PNI was determined to be 40 based on the original investigation by Onodera et al.[18] The mGPS was contrasted as follows: Patients with both an elevated C- reactive protein (>10 mg/l) and hypoalbuminaemia (<35 g/l) were allocated a score of 2. Patients in whom only one or none of these biochemical abnormalities were present allocated a score of 1 or 0, respectively by McMillan et al.[19] Data regarding patient characteristics, intraoperative variables, postoperative variables and episodes of SSI were collected. Wound infection was evaluated according to the Guidelines for the Centers for Disease Control and Prevention.[20]

2.2. Surgical technique

Preoperatively, all patients received mechanical bowel preparation. Half bottle of sodium picosulphate hydrate (50 ml) was given the day before surgery. Antibiotic prophylaxis was used in all patients. Cefotiam was given intravenously 30 min before surgery. Antibiotics were administered only once the day after surgery. Each patient was given general anaesthesia. The elliptical skin incision was made, with a cylindrical stoma takedown. Stoma takedown procedures included closure of diverting loop ileostomy and colostomy. A midline laparotomy was performed if the peristromal incision did not provide adequate exposure. Anastomosis was performed extracorporeally using the functional end-to-end method or intracorporeally using the double-stapling technique. To prevent surgical site infection, the surgical drapes surrounding the laparotomy were covered by a new set of drapes before transection of the bowel, a new set of instruments was used and glove-changing was performed after the anastomosis. For wound closure, the peritoneum and fascia were sutured together in an interrupted fashion using absorbable sutures. After the muscle layer was sutured, subcutaneous tissue was washed with warm physiological saline solution and scrubbed with a disposable sponge. In the CC group, the skin was sutured with 3 or 4 interrupted stitches with a non-absorbable monofilament suture. In the PC group, the skin was closed by using a pursestring subcuticular continuous suture with an absorbable multifilament suture, leaving an open of 5–10 mm circular gap.

2.3. Statistical analysis

Statistical analysis was performed using JMP 12 for Windows (SAS Institute, Inc., Cary, NC, USA). Student's *t*-test, the Mann-Whitney *U* test and the χ^2 test were used to compare continuous and categorical variables as appropriate, with two-sided $P < 0.05$ indicating statistical significance. One-to-one matching was performed without replacement using a caliper width of 0.2 standard deviations of the logit of the estimated propensity score.[21] After PSM, the two matched groups were handled as unpaired independent group. Multivariate analysis was performed using logistic regression.

3. Results

A total of 360 patients underwent surgery for stoma closure in our institution. In 148 patients underwent conventional linear closure (CC), and in the remaining 212 patients underwent pursestring closure (PC). Characteristics, comorbidities and risk factors, such as gender, age, BMI, diabetes mellitus, history of smoking (active smoker or non-smoker/smoking cessation for more than 12 months), steroid use, ASA classification, PNI and mGPS did not differ significantly between the CC group and the PC group. Table 1 shows the patient backgrounds in both groups were closely balanced by the PSM, which resulted in 64 matched pairs.

Data regarding operative time, blood loss, anastomosis, postoperative complications and hospital stay were collected in a database (Table 2). There were no significant differences in median operative time, median blood loss or anastomosis when comparing the two groups. There were no perioperative deaths. Postoperative complications between the CC group and the PC group were comparable with regards to number of overall SSI (25.0 vs. 7.8%; $P = 0.007$), superficial SSI (21.9 vs. 4.7%; $P = 0.003$), deep SSI (3.1 vs. 3.1%; $P = 1.000$), bleeding (1.6 vs. 3.1%; $P = 0.555$), ileus (6.3 vs. 6.3%; $P = 1.000$) and leakage (3.1 vs. 1.6%; $P = 0.555$). The median hospital stay after surgery was shorter in the PC group (10 days) than in the CC group (13.5 days; $P = 0.017$). The rate of stoma site incisional hernia was (9.4 vs. 10.9%; $P = 0.212$). The median (range) follow-up period was 72 (12–195) months. The stoma site incisional hernia occurred on the median range of 10 months after stoma reversal surgery. SSI developed after stoma closure in 21 (16.4%) of the 128 patients. On univariate analysis, the SSI group and the no SSI group were comparable with regard to gender ($P = 0.502$), age (75 ≤ years, 4.7 vs. 7.5%; $P = 0.641$), BMI (25≤, 19.1 vs. 13.1%; $P = 0.488$), incidence of diabetes mellitus (4.8 vs. 10.3%; $P = 0.392$), incidence of smoking history (38.1 vs. 46.7%; $P = 0.465$), ASA classification (III≤, 0 vs. 1.9%; $P = 0.395$), PNI (40<, 0 vs. 0%), mGPS (≤1, 9.5 vs. 0.9%; $P = 0.048$), incision (linear closure, 76.2 vs. 44.9%; $P = 0.007$) (Table 3). Multiple analyses revealed only the incision (linear closure) to be an independent risk factor for SSI (Table 4).

4. Discussion

Several randomized controlled trials have demonstrated the lower rate of stoma site SSIs associated with the PC group compared with the CC group.[10–12] The SSI rate of the PC technique ranges from 0 to 6.7%.[10–12,22–25] According to the cosmetic outcomes, a recent meta-analysis reported the PC group had a significant higher satisfaction than the CC group.[13] Camacho-Mauries et al.[11] reported there were no differences in pain and wound management between groups. However, there were few reports that describe the incisional hernia associated with this management strategy for long-term follow up. The rate of incisional hernia after stoma reversal surgery reported that occurs on an average of 9 months and as high as 36%.[26,27] In addition, recently, preoperative systematic inflammatory response, such as modified Glasgow Prognostic Score, was associated with poor outcome in colorectal cancer.[15] The Prognostic Nutritional Index (PNI) was also shown recently to be a predictive marker for both postoperative complications and prognosis in patients.[16,17] To the best of our knowledge, the present study is the largest series of its kind to evaluate the impact of pursestring wound closure on outcomes following stoma reversal by using PSM analysis.

In the present study, patients were mainly temporary stoma for rectal cancer. This is likely related to the high utilization of defunctioning stoma for low anterior resection, intersphincteric rectal resection. The two groups (CC group and PC group) were well matched for gender, age, preoperative patient characteristics (e.g. diabetes mellitus, history of smoking, steroid use, primary disease, BMI, ASA classification, PNI, mGPS), and there was no difference in

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