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Original Research Article

A comparative study of primary skin and subcutaneous tissue closure and open skin technique in emergency laparotomy for perforative peritonitis: an observational and prospective study

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ABSTRACT

Background: Surgical site infections (SSI) are major complications following laparotomy for perforative peritonitis largely affecting the quality of life, increasing morbidity and mortality. The study conducted seeks the factors that may be associated with post-operative surgical site infection.
Methods: A comprehensive observational and prospective study reporting advantages and disadvantages of Primary Closure (PC) and Delayed Primary Closure (DPC) for SSI, duration of hospital stay and morbidity following various aetiologies of perforative peritonitis requiring emergency laparotomy.
Results: Incidence of SSI was less in the DPC group (7.4%) compared to the PC group (42.9%) (p= 0.0040. Length of hospital stay was comparable in both groups, mean 13.52 days in the DPC group versus 14.07 days in the PC group (p=0.586). Significantly higher rates of SSI were found in patients with ASA grade >2 (p=0.012). Duration of surgery >4 hours and intra-operative transfusion were also found to have higher rates of SSI, but these differences were not significant (p=0.181 in both cases). Incidence of SSI did not have any co-relation with site of perforation.
Conclusions: SSI increases the hospital stay by approximately 5 days average. DPC significantly reduces the incidence of SSI in perforative peritonitis patients but the advantage of DPC over PC is questionable. Patients with ASA grades >2 were found to have significantly higher rates of SSI. Patients with >4hours surgery and patients with intra-operative transfusion also had higher rates of SSI, but this was not significant. Site of perforation have no co-relation with incidence of SSI.

Keywords: Delayed primary closure, Primary closure, Surgical site infection

INTRODUCTION

Surgical site infection (SSI) is a major complication after surgical procedures, especially after laparotomy for perforative peritonitis. It increases morbidity, hospital stay, cost of treatment and diminishes patient satisfaction especially in a resource-constraint country like India. Abdominal wall closure in the presence of sepsis is challenging to surgeon. In presence of peritonitis, the gut is oedematous and presence of sepsis in the peritoneal cavity causes exudation. After peritoneal cavity washing, if tight closure of abdominal wall is done, it may lead to compartment syndrome or wound dehiscence or burst abdomen in a significant number of patients. Surgical Site Infections develop as a result of contamination with microorganisms which is mostly patients' flora (endogenous source) commonly 5 to 6 days postoperatively when integrity of the skin and/or wall of

a hollow viscus is violated. Surgical wounds can be clean, clean-contaminated, contaminated and dirty. The surgical wound site of laparotomy in cases of perforative peritonitis falls under the category of clean contaminated wound, where the infection rate of wound site is 5-8%.[1] A surgical wound is considered infected if 1) there is drainage of purulent materials from the wound, 2) the wound spontaneously opens and drains purulent fluid, 3) the wound drains fluid that is culture positive or gram stain positive for bacteria 4) the surgeon notes erythema and drainage and opens the wound after determining it to be infected.

Acute wound failure (wound dehiscence or a burst abdomen), the most dreaded complication, refers to postoperative separation of the abdominal musculoaponeurotic layers occurring in approximately 1% to 3% patients undergoing abdominal operations and has multiple predisposing factors of which intra-abdominal infection is an important one.

Primary closure can be done in clean contaminated wounds after thorough peritoneal lavage. Another option is delayed primary suture leaving the skin and subcutaneous tissue widely open. The wound is to be dressed with normal saline soaked gauze every day and delayed suturing done usually after about five days if the wound is healthy.[2]

This study is to compare open skin technique and primary closure of skin and subcutaneous planes after laparotomy in cases of Peritonitis. I would like to evaluate advantages and disadvantages of these two techniques with regard to surgical site infections, duration of hospital stay and morbidity following various aetiologies of perforative peritonitis requiring emergency laparotomy.

METHODS

The study conducted at R.G. Kar Medical College and Hospital; Department of General Surgery. It is a tertiary care teaching hospital catering a cosmopolitan population of a metropolitan city and the surrounding districts and also the adjoining states and country. The study period was January 2015 to June 2016 - sixteen (16) months. All Patients admitted in General Surgery In-Patient-Department of R.G. Kar Medical College and Hospital with Perforative Peritonitis who have undergone emergency laparotomy

Inclusion criteria

- All patients, aged >12 years and <80 years,
- Undergoing surgical intervention for perforative peritonitis after taking informed consent.

Exclusion criteria

- Immunocompromised patients,
- Age ≤12 years and ≥80 years,
- Patients with pre-existing skin infection,
- Patients having diabetes mellitus, obesity or chronic renal failure,
- Patients taking immunosuppressive therapy for other causes,
- Patients not willing to participate in the study,
- Patients who needs laparostomy.

Sample size

Sixty patients of perforative peritonitis undergoing surgical intervention for perforative peritonitis, were selected; 30 consecutive cases underwent open skin technique and 30 primary closure (PC).

A comprehensive observational and prospective study reporting advantages and disadvantages of Primary closure and open skin technique with regard to surgical site infections, duration of hospital stay and morbidity following various aetiologies of perforative peritonitis requiring emergency laparotomy.

Study tools

- History
- Clinical examination
- Straight X-ray abdomen
- Blood TLC and DLC
- Culture sensitivity of peritoneal fluid collected intra-operatively
- Culture sensitivity of pus/swab from the wound.

A pre-formed data collection sheet will be used to compile the above data.

Study technique

The study was conducted after approval by the Institute of Ethics Committee. Informed written consent was taken from each subject before inclusion in the trial. Detailed history taking, and clinical examination were done, along with blood and imaging investigations. Patients fulfilling inclusion criteria were randomly selected for the study. Patients were divided into two groups. One group underwent open skin technique followed by DPC of skin wound or healing by secondary intention (n = 30) and the other PC (n = 30).

All patients received empirical therapy with intravenous Ceftriaxone-Sulbactam 1.5g metronidazole 500mg preoperatively and post-operatively, till C/S report of peritoneal fluid, collected intra-operatively, was available and targeted antibiotic therapy instituted.

Abdominal sheath was closed with polypropylene no.1 (for midline incisions) and polyglactin no.1 (for grid iron incisions), in a single layer continuous fashion. Skin was

closed with 2-0 polyamide black on a curved cutting needle, in interrupted fashion with no subcutaneous sutures.

For the open skin group, after closing rectus sheath, skin sutures were placed without tying the knots. The skin wound was left covered with saline-soaked gauze after irrigation with normal saline and was not manipulated until post-operative day 2. On day 2 a wound swab was sent for C/S and the dressing was changed using sterile technique after normal saline lavage. Twice daily dressing with normal saline continued till day 4, when the wound was evaluated for closure. If there was no discharge or sign of inflammation (like erythema, induration or increased local temperature), the wound was closed by tying the sutures in situ. Otherwise, dressing was changed twice daily till signs of wound infection completely subsided. Patients were followed up to 30 days from the time of PC or DPC, for any sign of wound infection. In the study group of patients, if a wound infection was suspected before post-operative day 2 based on appearance or odour of the wound or systemic signs (fever, tachycardia), dressing was removed, wound inspected and repacked after normal saline lavage. For both PC and open skin groups, stitch removal was done 10 days after closure.

However, if wound infection was present, one or more stitches may be removed, pus/ swab from the wound sent for C/S and daily dressing of the wound continued. Tabulation of data and graphical presentation using charts and tables were done. Appropriate statistical tests relevant to data size were performed to derive a conclusion.

Study parameters

Demographic and clinical variables recorded at the time of admission and thereafter

- Pre-operative ASA grading: grade 1-2 or 3-5
- Site of perforation: gastric/duodenal/jejunal/ileal/ appendicular/colonic/multiple
- Type of surgery: primary repair/resection anastomosis/stoma/ appendicectomy
- Duration of surgery: <4hrs or >4hrs
- Intra-operative transfusion of blood/ blood products

Condition of wound

- Presence of wound infection-any purulent discharge, pus/swab C/S,
- Possible wound infection-signs of inflammation/serous discharge.

Schedule of data collection

Data will be collected in predesigned proforma after getting the clinical assessment and cytological and radiological reports.

Statistical analysis

The data will be compiled in a Microsoft Excel sheet, and then statistical analysis will be done accordingly with suitable statistical software (SPSS ver.22.0).

RESULTS

The study is an observational and descriptive. Sixty patients with perforative peritonitis of varying aetiology who underwent exploratory laparotomy were included in the trial.

Distribution of patients

Open skin (OS) group (n=30): underwent delayed primary closure (DPC) of skin wound or secondary healing (Table 1). Primary closure (PC) group (n=30): underwent primary closure (PC) of skin wound.

Table 1: Distribution of patients.

Group	No. of patients	Percentage (%)
Primary closure group	30	50%
Open skin group	30	50%
Total	60	100%

Incidence of SSI

Among patients who underwent primary closure, 42.9% developed SSI, whereas only 7.4% patients in the DPC group had SSI. This was statistically significant (p = 0.004). Therefore, DPC results in significant decrease in SSI.

However, a point worth noting is that the average timing of DPC was the 9th POD. Till the time of DPC, these wounds were potentially infected. But presence of any infection in wounds left open for DPC have not been considered as SSI.

Table 2: Distribution of patients based on SSI.

SSI	Open skin group (n=29) n (%)	Primary closure group (n=28) n (%)	p value	Significance
Yes	4 (13.7)	12 (42.9)	0.004^	Significant
No	25 (92.6)	16 (57.1)		

^ Significance calculated using Fisher's exact test

Two patients in the control group and one in the study group died in the post-operative period and were not included in the calculation of SSI. Also, two patients in the study group who did not undergo DPC were not included in this calculation (Table 2).

Length of hospital stay

Length of hospital stay was comparable in the two groups (average 13.52 days in DPC group and 14.07 days in PC group; p = 0.586) (Table 3).

Co-relation between pre-operative ASA grade and SSI

SSI was present in 20% of patients with ASA grade ≤2 and in 80% patients with ASA grade >2. The difference is statistically significant (p = 0.012), suggesting that patients with higher ASA grades have higher risk of wound infection (Table 4).

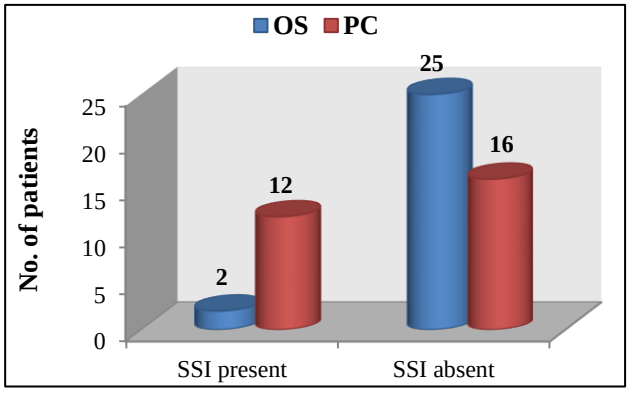

Figure 1: Distribution of patients based on SSI.

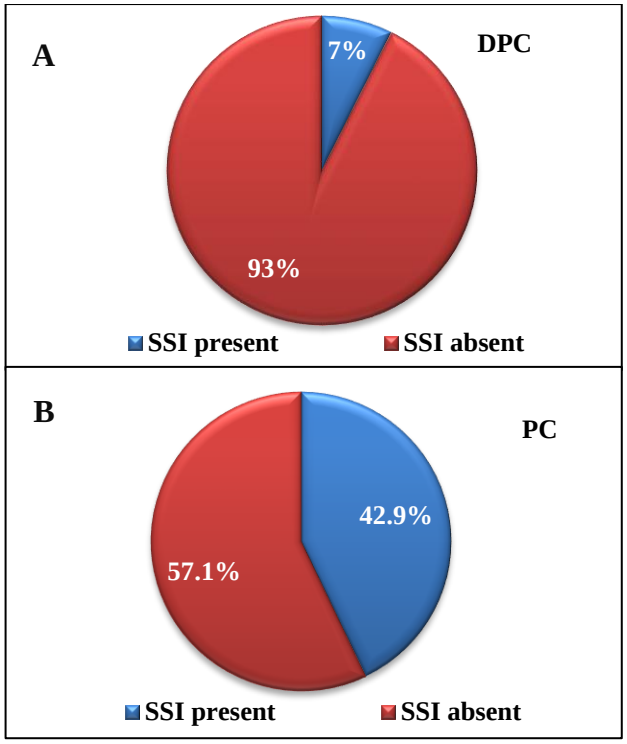

Figure 2: (A) Distribution of patients based on SSI in delayed primary closure group, (B) Distribution of patients based on SSI in Primary Closure group.

Table 3: Distribution of hospital stay in the two groups.

Parameters	Open Skin group (n=27) Mean±SD (range)	Primary Closure group (n=28) Mean±SD (range)	p value	Significance
Length of hospital stay	13.52±2.55 (7-26)	14.07±4.60 (7-25)	0.586#	Not significant

#Significance calculated using independent sample t-test.

Table 4: Co-relation between pre-operative ASA and SSI.

Pre-operative ASA grade	SSI present (n=14) n (%)	SSI absent (n=41) n (%)	p value	Significance
≤2	10 (20)	40 (80)	0.012^	Significant
>2	4 (80)	1 (20)		

^ Significance calculated using Fisher's exact test.

Table 5: Co-relation between duration of surgery and SSI.

Duration of surgery	SSI present (n=14) n (%)	SSI absent (n=41) n (%)	p value	Significance
<4 hours	10 (21.3)	37 (78.7)	0.181^	Not significant
>4 hours	4 (50)	4 (50)		

^ Significance calculated using Fisher's exact test.

Table 6: Co-relation between intra-operative transfusion and SSI.

Intra-operative transfusion	SSI present (n=14) n (%)	SSI absent (n=41) n (%)	p value	Significance
Yes	4 (50)	4 (50)	0.181^	Not significant
No	10 (21.3)	37 (78.7)		

^Significance calculated using Fisher's exact test.

Table 7: Co-relation between SSI and site of perforation.

Site of perforation	SSI present (n=14) n (%)	SSI absent (n=41) n (%)	p value	Significance
Gastric	1 (6.7)	14 (93.3)	0.107^	NS
Duodenal	3 (37.5)	5 (62.5)	0.684^	NS
Jejunal	1 (25)	3 (75)	0.565^	NS
Ileal	3 (33.3)	6 (66.7)	0.861^	NS
Appendicular	3 (18.8)	13 (81.2)	0.696^	NS
Caecal/ colonic	3 (100)	0 (0)	0.014^	Significant

^Significance calculated using Fisher's exact test.

Co-relation between duration of surgery and SSI

Wound infection rate was much lower in patients with operating time <4 hours (21.3%) compared to those with operating time >4 hours (50%). Therefore, duration of surgery >4 hours increases the incidence of SSI. However, this difference was not statistically significant (p = 0.181) (Table 5).

Co-relation between intra-operative transfusion and SSI

Fifty percent patients who had intra-operative transfusion later developed SSI, whereas only 21.3% patients in the non-transfused group developed SSI. Therefore, intra-operative transfusion may have an association with development of SSI. However, this was not statistically significant (p = 0.181) (Table 6).

Co-relation between site of perforation and SSI

Although SSI rate was much lower in gastric perforations (6.7%) compared to other sites, no statistical significance was found (p=0.107). SSI rates in various parts of small gut, i.e. duodenum, jejunum and ileum are comparable, as is in case of appendicular perforation. Caecal or colonic perforation was associated with a 100% SSI rate; however, considering the small number of large gut perforations (3 out of 55), it is difficult to comment on the statistical significance (Table 7).

DISCUSSION

Surgery in perforative peritonitis patients is associated with the highest rates of post-operative infective complications, especially surgical site infections, because of contamination of the operative field with microorganisms from endogenous sources. These infections occur despite all kinds of measures and may cause wound disruption, fascial dehiscence, patient discomfort, bad cosmesis, prolonged hospital stay and increased cost of treatment.[3,4] The primary outcome measures in present study were incidence of SSI, length of hospital stay. Length of hospital stay was significantly higher in patients with SSI. An SSI, on an average, increased the hospital stay by approximately 5 days.

Incidence of SSI was significantly less in the DPC group according to Table 2. However, the average timing of DPC was 9.19 days, which implies that the wound was potentially infected before that and considered inappropriate for closure. However, this is considered as skin and soft tissue infection and not as SSI.

Length of hospital stay was also comparable in the two groups according to Table 3. Authors have not compared treatment expenses and quality of life in the two groups. Length of hospital stay may be considered a surrogate marker of these two parameters.

Thus, although incidence of SSI was much lower in DPC group, these wounds were actually infected for quite some time post-operatively, and length of hospital stay was not reduced in these patients, compared to PC group. Moreover, most of the patients in the DPC group were not comfortable with a gaping wound, especially long midline incisions.

Since the fundamental idea is to reduce the hospital stay, treatment expenses and improve the quality of life of patients, the advantage of DPC over PC in perforative peritonitis is questionable.

Below is a list of various studies comparing PC and DPC in contaminated or dirty abdominal wounds, including three meta-analyses. Except for the study by Grosfeld et al, all the others are prospective randomised studies. The most recent meta-analysis by Bhangu et al, has suggested that DPC may have a role in reducing the rate of SSI in contaminated and dirty abdominal incisions, but no definitive evidence was found as all studies analyzed were found to be at high risk of bias, with deficiency in study design and outcome assessment.[5] Thus, DPC significantly reduced chance of SSI, when a fixed effect model was used. However, when a random effect model was used, the difference was not significant.

Apart from these primary outcome measures, the study also revealed some other interesting associations:

- Patients with ASA grades >2 were found to have significantly higher rates of SSI as per Table 4.

- Patients with duration of surgery >4 hours and patients with intra-operative transfusion also had higher rates of SSI, but this difference was not significant as per table 5 and 6 respectively.
- Site of perforation were found to have no co-relation with incidence of SSI as per Table 7.

Table 8: Different studies showing preferred methods in different patients population.

Year	Study	Patient population	Conclusion (preferred method)
2013	Bhangu et al[5] (meta-analysis)	Contaminated and dirty abdominal incisions	DPC (fixed effect model) /No significant difference (random effect model)
2012	Khan et al[6] (Pakistan)	Complicated appendicitis	PC
2011	Chiang et al[7](China)	Perforated appendicitis	DPC
2009	Duttaroy et al[8] (India)	Dirty abdominal incisions	DPC
2005	Henry et al[9] (meta-analysis)	Complicated appendicitis	PC
2001	Cohn et al (U.S.A.)[10]	Dirty abdominal incisions	DPC
2000	Rucinsky et al[11] (meta-analysis)	Gangrenous and perforated appendicitis	No significant difference
1992	Tsang et al[12]	Gangrenous and perforated appendicitis in children	No significant difference
1981	Pettigrew et al[13]	Gangrenous and perforated appendicitis	PC
1972	Andersen et al[14]	Perforated appendicitis	No significant difference
1968	Grosfeld et al[15] (U.S.A.)	Perforated appendicitis	DPC

In a study conducted by Ahmet et al, in colorectal surgeries, there was a significant increase in the rate of SSI for higher ASA grade (3-5) with p value of 0.001.[16] Mawalla et al, reported SSI rates for ASA classification I, II and III were 15.2%, 62.8% and 88.9% respectively (p-value = 0.001).[17] Kaya et al, reported a statistically significantly higher SSI incidence for those with an ASA score of 3 or greater compared with those with an ASA score of 1 or 2 (OR 3.0, 95% CI 2.6 to 3.2).[18]

Mawalla et al, reported a statistically significant association between the duration of operation and SSI (p-value = 0.0001).[17] Ahmed et al, reported increased rate of SSI with increase in the duration of surgery.[19] Sahu et al, reported higher incidence of SSI with surgeries lasting more than 2hours (24.3%).[20]

A similar trend was found in a study by Anvikar et al, which reported 2.6% SSI in surgeries of duration less than 1hour, 4.8% SSI in surgeries between 1-2hours and 5.4% SSI if duration more than 2hours.[21] 1-2hour duration surgeries have significantly higher ($p<0.02$) infection rate than those less than 1hour duration. From a study done in Thailand, Kasatpibal et al, also reported an incidence of infection of 0.9% in surgeries less than 1hour and 2.5% SSI in surgeries lasting for more than 1hour.[22] Ahmet et al, found intra-operative transfusion to be an independent risk factor for SSI (p = 0.01) in patients undergoing colorectal surgery.[16]

CONCLUSION

Each SSI, on an average, increases the hospital stay by approximately 5 days. Delayed primary closure significantly reduces the incidence of SSI in perforative peritonitis patients, compared to primary closure. However, it takes quite a while (on an average, 9.19 days) before such wounds become infection-free and appropriate for closure. As a result, the length of hospital stay in delayed primary closure is comparable to that in primary closure patients. In view of the above, the advantage of delayed primary closure over primary closure of perforative peritonitis wounds is questionable. Patients with ASA grades >2 and were found to have significantly higher rates of SSI. Patients with duration of surgery >4hours and patients with intra-operative transfusion also had higher rates of SSI, but this difference was not significant. Site of perforation were found to have no co-relation with incidence of SSI.

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