Comparison of superficial surgical site infection between delayed primary and primary wound closures in ruptured appendicitis

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KEYWORDS
appendicitis; delayed primary closure; surgical site infection; wound closure

Summary  Background: Delayed primary (DPC) and primary (PC) wound closures have been applied in ruptured appendicitis, but results were controversial. This study aims at comparing the rate of superficial surgical site infection (SSI) in ruptured appendicitis between DPC and PC. Methods: A retrospective cohort of ruptured appendicitis was conducted between October 2006 and November 2009. Demographic, operative findings and postoperative infection data were retrieved. The superficial SSI rates between groups were compared using an exact test. An odds ratio of SSI was then estimated. Results: One-hundred and twenty eight patients with ruptured appendicitis were eligible and their data were retrieved; 115 (90%) patients had received DPC and 13 (10%) patients had received PC. The SSI rate was much lower in PC patients than in DPC patients, i.e., 7.7% [95% confidence interval (CI): 0.02, 36.0] versus 27.8% (95% CI: 19.9, 37.0), respectively. There was an approximately 72% lower risk of SSI in the PC group than in the DPC group, but this did not reach statistical significance (p = 0.18). Conclusion: Our study suggested that PC does not increase risk of SSI in low SSI risk patients with ruptured appendicitis. DPC should not be routinely done.

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1. Introduction

Appendectomy is one of the most common emergency surgical procedures in the world.1-2 The most common postoperative complication after appendectomy is superficial surgical site infection (SSI),3 which especially occurs in complicated appendicitis (i.e., gangrenous, and ruptured appendicitis).4 Superficial SSI causes readmission, increases the length of stay, nursing care, and prolonged antibiotic treatment.5,6 Consequently, this results in an increase in both direct and indirect medical costs to both health care providers and patients.5-7

Postoperative SSI can be minimized by reducing risk factors (e.g., smoking, or glucose control),5,9 or use of established preventive procedures (e.g., prophylactic antibiotics, avoid surgical drain, and unnecessary hair removal).9 Closure of the wound with delayed primary closure (DPC) for a contaminated wound also affected SSIs.9-11 Instead of closing a wound primarily, the wound is left open with standard wound care and then is closed on the 3rd to 5th day afterward.12,13 This procedure is claimed to increase local wound resistance14 and decrease bacterial contamination.11,15 which results in a decrease in superficial SSIs.9,11,13,14 However, DPC has disadvantages compared to primary closure (PC); these are patient discomfort and pain from dressing, increased length of stay, and increased cost of treatment.16 Nevertheless, DPC is still currently used and recommended in surgical practice by standard textbooks,3 with consideration of the wound classification and the attitude of the surgeon. We therefore conducted a retrospective cohort study with the aim of comparing superficial SSIs between DPC and PC in patients with ruptured appendicitis.

2. Methods

The study was approved by the Ethical Committee Board of Faculty of Medicine, Thammasat University. The study design was a retrospective cohort study. All patients with ruptured appendicitis that would be coded as acute appendicitis with peritonitis (ICD10 coding of K350), admitted to Thammasat University Hospital between October 2006 and November 2009, were identified from medical databases, and medical records were reviewed for eligibility. Patients were eligible if they were aged ≥15 years, had an appendectomy with right lower quadrant incision, and had pathological diagnosis of ruptured appendicitis. Patients with an additional midline incision, apart from the right lower quadrant incision, were excluded.

Data were retrieved from both inpatient and outpatient medical records using a standardized case record form. Baseline characteristics of the patients (sex and age), clinical data [diabetes, immunocompromised host (i.e., HIV, currently on immunosuppressive drugs), and ASA classification], and surgical data (operative time, use of surgical drain, and antibiotic prophylaxis) were retrieved.9 Intraoperative factors that might alter the magnitude of wound contamination (i.e., the presence of phlegmon, pus, and intraoperative rupture) were also collected.

Superficial incisional SSI was defined according to CDC criteria7 as follows: (1) infection occurring within 30 days postoperatively; and (2) involving only skin and subcutaneous tissue of the incision. One of the following conditions must also be met: (1) purulent drainage from the superficial incision; (2) organisms isolated from an aseptic culture of fluid or tissue from the superficial incision; (3) had at least one of the signs and symptoms (i.e., pain or tenderness, localized swelling, redness, or heat); or (4) superficial incision was deliberately opened by the surgeon with or without positive culture. DPC was defined as a wound that was left open initially after completion of an operation, whereas PC was a wound that was suture-closed immediately after an operation. The date of suturing in DPC to close the wound was also recorded. The ASA classification was re-categorized as <III and ≥III according to the National Nosocomial Infections Surveillance System Risk Index (NNIS index).18 Operative time was classified as <75th and >75th percentile16 of the average duration, which was 60 minutes; this is the time used for wound classification in appendectomy by the NNIS.9

2.1. Statistical analysis

Baseline characteristics of the patients were described using mean (or median where appropriate) and frequencies for continuous and categorical data, respectively. Demographic data, clinical data, and surgical factors mentioned previously were compared between DPC and PC groups using the t test (or Mann-Whitney test where appropriate) and Chi-square test (or Fisher’s exact test) for continuous and categorical data, respectively. The rate of SSIs between groups and the 95% confidence intervals (CI) were estimated. The risk ratio (RR) of superficial SSI for PC versus DPC was then estimated. Analysis was performed by STATA version 12.0; p < 0.05 was considered as statistically significant.

3. Results

The medical records of 184 cases identified during the study period were reviewed. Among them, 20 patients were <15 years old, 17 patients had additional midline incisions, leaving 147 patients who met the eligibility criteria. Of these, 19 (13%) patients did not have data for superficial SSI, leaving 128 patients for analysis.

The mean age of the 147 patients was 37 years (SD = 17) and 96 (65%) were men. Nine (6%) patients had diabetes and none were taking immunosuppressive drugs. All patients were prescribed a prophylaxis antibiotic. The median duration of symptoms before admission was 24 hours, with a range of 1-96 hours. One-hundred and thirty eight patients (94%) were categorized in ASA Class I and II, and 9 (6%) patients were ASA Class III or higher. The median operative time was 75 minutes, with a range of 25-405 minutes. The average duration of re-suture after DPC was 4 days (SD = 1.9) post-operation. The average length of stay (LOS) was 6.5 days (SD = 3).

Among 128 patients, 115 (90%) and 13 (10%) patients received DPC and PC, respectively. Characteristics of the patients were compared between the two groups (Table 1). Thirty-three patients had superficial incisional SSI, with an overall rate of 25.7% (95% CI: 18.5, 34.3). The SSI rate
tended to be lower in the PC than the DPC group, with rates of 7.7% (95% CI: 0.02, 36.0) versus 27.8% (95% CI: 19.9, 37.0), respectively (Table 2). The estimated RR was 0.28 (95% CI: 0.04, 1.86), i.e., patients who received PC would be at an approximately 72% lower risk of SSI than patients who received DPC, but this was not significantly different. LOS was 6.6 days (SD = 3.1) and 5.8 days (SD = 2.5) after DPC and PC, respectively (p = 0.36). The average day of resuture after DPC were 4.8 days (SD = 2.4) and 4.3 days (SD = 1.6) in SSI and non-SSI, respectively. No other risk factors were significantly associated with SSI, except duration of operation, which showed a trend of association with the estimated RR of 1.82 (95% CI: 0.92, 3.60; p = 0.07). This suggested that an operative time > 60 minutes might increase the risk of wound infection.

4. Discussion

We conducted a retrospective cohort study including 128 patients with ruptured appendicitis. The superficial SSI rate was approximately 72% lower in PC than in DPC patients, although this was not significant. An operative time > 60 minutes seemed to be a risk factor for SSI.

Our results are similar to those of a previous systematic review and meta-analysis in pediatric patients and a randomized controlled trial of ileostomy closure, which found that PC did not increase the rate of wound infection after operation, thus encouraging applying PC due to the lack of benefit of DPC. By contrast, some studies found a considerable benefit of DPC. For instance, Duttaroy et al conducted a randomized controlled trial in peritonitis patients with a midline abdominal incision. They found that superficial SSI was significantly lower in the DPC group than in the PC group (42.5% vs. 2.7%), with a number needed to treat of 2.5. This finding is also observed after DPC in other types of patients (i.e., contaminated wound and open tibial fracture). These discrepant results might be due to heterogeneous patients with different types of operation (appendicitis, other procedures), types of patients (adult, children), and incision (midline, right lower quadrant). As a result, there should be caution in applying the results of these findings to patients.

The prevalence of superficial SSI after PC in ruptured appendicitis varied from 9% to 50%, with a number needed to treat of 2.5. This may be explained by a different definition of superficial SSI, different care, and setting of patients. DPC may be of benefit if the SSI rate is low, as demonstrated by one cost-utility analysis. Improvement of healthcare and operative techniques can decrease postoperative superficial SSIs and thus DPC may be required less.

Risk factors for postoperative SSI may subjectively influence a physician’s judgment to apply or not apply DPC, other than wound classification (i.e., clean, clean-contaminated, contaminated, and dirty). Some risk factors (i.e., operative duration and ASA classification) other than wound classification have been validated and included in risk classification scores by NNIS for better prediction of postoperative superficial SSI. However, some other risk factors that can influence a physician’s judgment to apply DPC have not been studied with regards to their magnitude of association. These include the degree of wound contamination (e.g., degree of intraoperative contamination of incision with pus or feculent

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**Table 1** Baseline characteristics of patients compared between groups with and without delayed primary closure.

<table>
<thead>
<tr>
<th>Variables</th>
<th>PC</th>
<th>DPC</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>37 (17)</td>
<td>41 (18)</td>
<td>0.42</td>
</tr>
<tr>
<td>Male</td>
<td>8 (62%)</td>
<td>87 (65%)</td>
<td>0.77</td>
</tr>
<tr>
<td>Female</td>
<td>5 (38%)</td>
<td>47 (35%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>1 (8%)</td>
<td>8 (6%)</td>
<td>0.58</td>
</tr>
<tr>
<td>Symptom duration (h)</td>
<td>24 (1, 96)</td>
<td>24 (14, 48)</td>
<td>0.99</td>
</tr>
<tr>
<td>ASA classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASA 1, 2</td>
<td>12 (92%)</td>
<td>108 (94%)</td>
<td>0.59</td>
</tr>
<tr>
<td>ASA 3, 4</td>
<td>1 (8%)</td>
<td>7 (6%)</td>
<td></td>
</tr>
<tr>
<td>Operative duration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;60 min</td>
<td>4 (31%)</td>
<td>48 (42%)</td>
<td>0.45</td>
</tr>
<tr>
<td>&gt;60 min</td>
<td>9 (69%)</td>
<td>67 (58%)</td>
<td></td>
</tr>
<tr>
<td>Presence of phlegmon</td>
<td>3 (23%)</td>
<td>9 (8%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Presence of pus</td>
<td>5 (38%)</td>
<td>40 (35%)</td>
<td>0.77</td>
</tr>
<tr>
<td>Intraoperative rupture</td>
<td>2 (15%)</td>
<td>13 (11%)</td>
<td>0.65</td>
</tr>
<tr>
<td>Drain placement</td>
<td>2 (15%)</td>
<td>7 (6%)</td>
<td>0.23</td>
</tr>
</tbody>
</table>

* Chi-square test.  
DPC = delayed primary closure; PC = primary closure.  
A Mean (SD).  
B Median (range).

**Table 2** Univariate analysis of risk factors for postoperative superficial surgical site infection.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Superficial SSI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of closures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPC</td>
<td>32 (97%)</td>
<td>0.12</td>
</tr>
<tr>
<td>PC</td>
<td>1 (3%)</td>
<td>12 (13%)</td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>19 (58%)</td>
<td>0.43</td>
</tr>
<tr>
<td>Female</td>
<td>14 (42%)</td>
<td>32 (32%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2 (6%)</td>
<td>6 (6%)</td>
</tr>
<tr>
<td>Symptom duration (h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;60 min</td>
<td>9 (27%)</td>
<td>43 (45%)</td>
</tr>
<tr>
<td>&gt;60 min</td>
<td>24 (73%)</td>
<td>52 (55%)</td>
</tr>
<tr>
<td>Presence of phlegmon</td>
<td>1 (3%)</td>
<td>11 (12%)</td>
</tr>
<tr>
<td>Presence of pus</td>
<td>12 (36%)</td>
<td>33 (35%)</td>
</tr>
<tr>
<td>Intraoperative rupture</td>
<td>4 (12%)</td>
<td>11 (12%)</td>
</tr>
<tr>
<td>Drain placement</td>
<td>2 (6%)</td>
<td>7 (7%)</td>
</tr>
</tbody>
</table>

* Chi-square test.  
DPC = delayed primary closure; PC = primary closure; SSI = surgical site infection.  
A Mean (SD).  
B Median (range).
content), and the host defense mechanism (i.e., subcu-
taneous fat thickness, age, immunosuppressive, diabetes,
and other comorbidity). More accurate risk classification
scores, by including all possible risk factors, can help a
physician to more accurately estimate the probability of
postoperative superficial SSI and lead to better wound
management decisions.

Our study was a retrospective cohort which was prone
to bias from the selection of patients. Since DPC was the
standard wound management for ruptured appendicitis in
our setting, only about 10% of patients received PC. Pa-

tients with a good prognosis might be selected by surgeons
to received PC rather than DPC, thus resulting in an un-
balanced proportion in SSI and non-SSI groups. Our results

did not meet with the standard practice of the 3rd to 7th
day. These patients may be appropriately managed
by secondary intention, to prevent SSI after re-suturing.

Although the mean re-suturing day was Day 4 after an
operation, some wounds were sutured after 1 week, which
did not meet with the standard practice of the 3rd to 7th
day. These patients may be appropriately managed
by secondary intention, to prevent SSI after re-suturing.
However, we did not find a difference in re-suturing day
between SSI and non-SSI in the DPC group. Our results
demonstrated that the risk of SSI after DPC is high (about
28%), which emphasized the necessity of developing deci-
sion criteria for re-suturing, and that some patients may
benefit from secondary intention instead. Patients with
low-risk ruptured appendicitis (e.g., non-diabetes, ASA
classification 1–2, short operative time, minimal contami-
nation) may be safely sutured closed.

5. Conclusion

Our study suggested that the risk of SSI in ruptured
appendicitis was not different between PC and DPC tech-
niques. Our results might be prone to selection and con-
 founding biases, therefore, a further large scale
randomized clinical trial, with good research methodology,
should be conducted. Cost-utility analysis of PC versus DPC
should be also further determined.

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