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Original Article

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## Wound Infection Incidence in Patients with Simple and Gangrenous or Perforated Appendicitis

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**Background:** Performing a delayed primary wound closure is often recommended in patients with gangrenous or perforated appendicitis who have undergone an appendectomy. It can result in increased pain as well as an extended hospital stay which, in turn, increases hospital costs. Delayed primary wound closure remains controversial. The general policy in our institution is to perform a primary wound closure. In this study, we have compared the incidence of wound infection in patients with simple appendicitis to those with gangrenous or perforated appendicitis whose wounds were primarily closed.

**Methods:** This is an observational study which was carried out on 400 patients with gangrenous or perforated (50%) and simple appendicitis (50%). Both groups underwent primary wound closure. Patients were followed for wound infection for at least one month after surgery. Data including age, sex, operating time, pathologic report and wound infection were collected. A comparison between the studied groups was made using Student's *t*-test for continuous variables and  $\chi^2$  test for categorical variables.

**Results:** The median age of the patients was 23 years. There were 141 (35.2%) females and 259 (64.8%) males. The median operating time was 30 minutes. Wound infections were observed in 15 patients (3.7%), including 6 cases of simple and 9 cases of gangrenous or perforated appendicitis which was not statistically significant.

**Conclusion:** There was no statistically significant difference in wound infection between the simple and gangrenous or perforated appendicitis groups.

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**Keywords:** Delayed wound closure • primary wound closure • simple and gangrenous or perforated appendicitis • wound infection

### Introduction

Despite the routine use of prophylactic antibiotics that target both aerobic and anaerobic organisms,<sup>1</sup> infection of the operative incision is the most common cause of morbidity after appendectomy. Therefore, it can result in increased pain and a lengthy hospital stay. In patients with non-perforated appendicitis the incidence of wound infection is <10%.<sup>2-4</sup> Wound

infection<sup>5</sup> increases with perforated appendicitis to 15% to 20% and is highest with diffuse peritonitis (35%).<sup>2</sup> Traditionally, in an effort to decrease the risk of operative site infection, gangrenous or perforated appendicitis has been managed with delayed primary closure.<sup>6,7</sup> Open wound management has previously been considered as the standard of care for most cases of acute appendicitis, particularly cases of perforated appendicitis.<sup>1</sup> These methods have been developed in response to the high rates of wound infections, up to 58%, seen in these cases. However, most reports predate the era of current antimicrobial therapy, which has led to decreased rates of wound infection (WI). Many studies in the 1980s and 1990s have reported low rates of infection using primary closure (PC), suggesting that such management might be safely and successfully

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used.<sup>7</sup>

Recent studies recommend primary wound closure in cases of gangrenous or perforated appendicitis. Chatwiriya (2002) and McGreal (2002) have shown that gangrenous or perforated appendicitis most often can be primarily closed.<sup>8,9</sup> In the pediatric as well as adult populations several trials have concluded that primary closure of all incisions is indicated.

Thus one of the most important reasons for the controversy in a primary or delayed closure<sup>5</sup> is post-surgical wound infection.<sup>1</sup> In this study, we have attempted to compare the incidence of wound infection after primary wound closure between patients with gangrenous or perforated versus patients with simple appendicitis.

## Patients and Methods

### Study population

In all patients with a clinical diagnosis of appendicitis who were operated on by our colleagues, the wound was primarily closed. The following data were collected: age, gender, operation time, and pathologic diagnosis. Patients were evaluated for any signs and symptoms of wound infection (erythema, induration, pain, and pus at the incision site) for at least one month following surgery by a surgeon who was blinded to the pathology report. At the end, patients were divided in two groups of simple and gangrenous/perforated appendicitis based on their pathology reports as follows: simple appendicitis (202 patients) which consisted of acute focal and acute suppurative; and the latter (198 patients) which were gangrenous and perforative.<sup>10</sup>

Exclusion criteria included the presence of peritonitis, abscess and phlegmon. The diagnosis of appendiceal abscess or phlegmon in suspected patients was confirmed either by ultrasonography or at laparotomy.

All patients with ASA 1 were included in the study. Wound infections were managed by opening the wound and irrigation with saline.

### Operative technique

All patients received intravenous perioperative

prophylactic cephalosporin and metronidazol before the skin incision and two postoperative doses. If gangrenous or perforated appendicitis was noted at the time of surgery, antibiotics were continued for at least 5 – 7 days. The McBurney incision and muscle-splitting technique was used. Care was taken to avoid contamination of the subcutaneous tissue and adjacent peritoneal cavity during the procedure. Moist packs were used to isolate the cecum and inflamed appendix. Appendectomy was performed with double stump ligation. The peritoneum, transverse muscle and aponeurosis of the external oblique muscle were sutured in layers. Before skin closure, the wound was irrigated copiously with warm saline. Scarpa's fascia and skin were closed with interrupted sutures. The skin and subcutaneous tissue were closed primarily.

### Statistical analysis

Patients' characteristics were analyzed using Student's t test for continuous variables and  $\chi^2$  test for categorical variables. A P value of less than 0.05 was considered to be statistically significant. All data analyses were performed using the SPSS program (version 11.5).

## Results

The median age of the patients was 23 years old (ranging from 7 to 64). There were 141 (35.2%) females and 259 (64.8%) males. Based on the American Society of Anesthesiologists (ASA) classification, all patients were placed in class 1. The median operation time was 30 minutes. The surgical wounds were closed primarily in 100% of the cases. The operation technique was the same in both groups. The male to female ratio in the simple appendicitis group was 123:79 and 136: 62 in the gangrenous and perforated group (Table 1).

There were 15 patients (3.7%) who developed wound infection that required opening and irrigation. No other major complications, such as an intra-abdominal abscess or perioperative mortality were seen. Simple appendicitis was diagnosed in 202 cases and gangrenous or perforated appendicitis in 198 cases,

**Table 1.** Frequency of sex, and age according to simple and gangrenous or perforated appendicitis ( $P=0.103$ )

Appendicitis type	Male	Female	Total
Simple	123 (60.9%)	79 (39.1%)	202
Gangrenous or perforated	136 (68.7%)	62 (31.3%)	198
Total	259 (64.8%)	141 (35.3%)	400

pathologically. Postoperative surgical wound infection had an incidence of 2.97% in the simple appendicitis group and 4.5% in the gangrenous or perforated appendicitis group. There was no statistically significant difference in wound infection between the simple and gangrenous or perforated appendicitis groups ( $P=0.407$ ; Table 2).

**Table 2.** Frequency of post-surgical wound infection (PWI) according to simple and gangrenous or perforated appendicitis ( $P=0.407$ )

Appendicitis type	PWI		Total
	Prevalence of PWI	No. PWI	
Simple	6 (2.97%)	196 (97.03%)	202
Gangrenous or perforated	9 (4.5%)	189 (95.5%)	198
Total	15 (3.75%)	385 (96.25%)	400

y=year; PWI=post-surgical wound infection

## Discussion

As with simple appendicitis, the outcome of future debates about gangrenous or perforated appendicitis will rest on potential differences in postoperative factors such as analgesia requirements, length of hospital stay, return to regular activity, and complication rates.<sup>11</sup> Some authors consider that preoperative antibiotic administration allows for primary closure of

reduction in cost.<sup>13,14</sup> Primary wound closure of acute appendicitis with perforation has also found its way into the management algorithm for adult patients without adequate assessment of adverse outcomes. Open wound management of contaminated wounds is a practical measure that has been used for centuries. Previous reports

indicate that the incidence of postoperative wound infection after appendectomy substantially increases with the severity of appendicitis and most infections occur after emergency appendectomy for perforated appendicitis.

Chiang et al. has reported that the presence of appendiceal perforation is the most important factor associated with the development of postoperative wound infection. They have concluded that in the presence of perforation,

**Table 3.** Characteristics of the included studies

Study	Location/year	Participants	Interventions	Definition of Wound Infection (WI)	WI/PC (%)	WI/DC (%)
Chatwiriyacharoen 2002 <sup>8</sup>	Surin, Thailand 1999	44 children less than 15 years old treated for perforated appendicitis	PC ( $n=22$ ) vs. DPC ( $n=22$ )	Presence of discharge of purulent material or surrounding cellulitis	2/22 (9.1)	6/22 (27.3)
Cohn 2001 <sup>15</sup>	Miami 1999	17 adults for perforated appendicitis	PC ( $n=8$ ) or DPC ( $n=9$ )	Drainage from wound reclusing closure on day 3 or requiring drainage in PC group	4/8 (50)	5/9 (55.6)
McGreal 2002 <sup>9</sup>	Ireland 1 year	60 adults and children with gangrenous or perforated appendicitis	PC ( $n=26$ ) vs. DPC ( $n=34$ )	Purulent discharge	2/26 (7.7)	8/34 (23.5)

WI=wound infection, PC=primary closure, DC=delayed closure

appendectomy wounds despite data suggesting that contaminated wounds have a higher rate of wound infection.<sup>12</sup> This practice has been aggressively pursued by the pediatric surgical community on the basis of its association with a “low” incidence of infectious complications, the elimination of painful and time-consuming dressing changes and

wounds should be left open to avoid an increased likelihood of wound infection and longer hospital stay.<sup>1</sup>

However, in this postoperative study surgical wound infection had an incidence of 2.97% in the simple appendicitis group and 4.5% in the gangrenous or perforated appendicitis group. This

difference was not statistically significant ( $P=0.407$ ; Table 2). Authors who also suggest primary closure in gangrenous or perforated appendicitis are listed in Table 3. Primary closure was performed in gangrenous or perforated appendicitis, because of low incidence of postsurgical infection or other complications.

In this study we have concluded that primary wound closure after appendectomy would be safe even in the presence of a perforation. Accordingly, a primary wound closure could be recommended in patients with gangrenous or perforated appendicitis as well as in those with a simple one.

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