Original Article

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Risk Factors for Surgical Site Infections After Appendectomy for Acute Appendicitis

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Abstract

Background: Surgical site infections are the most common hospital-acquired infections that increase overall cost and length of hospital stay, and are largely preventable. In the meantime, appendectomy remains a common surgical procedure related to a considerable risk of surgical site infections (SSIs). We aim to identify risk factors for SSI in patients who had undergone appendectomy in our setting. **Subjects and Methods:** A total of 292 patients who underwent open appendectomy between July 2017 to June 2021 in People's Dental College and Hospital, Kathmandu, Nepal were included. We divided patients into two groups based on the occurrence of SSI postoperatively; the SSI group and the non-SSI group. Patient demographic characteristics and perioperative data were compared between two groups. **Results:** Out of total 292 patients who underwent open appendectomy, 39 (13.4%) patients developed SSI. Mean ages were 31.8 ±8.08 years. In logistic regression analysis, on multivariate analysis, out of independent variables sex (male), presence of comorbidity, WCC (≥ 16000 /mm3)), CRP (≥ 65), type of appendicitis (complex), and duration of surgery (>60 mins), only WCC (≥ 16000/mm3)), and type of appendicitis (complex) were associated with an increased risk of SSI (P <0.005). **Conclusion:** White cell counts (≥ 16000/mm3)), and type of appendicitis (complex) were associated with an increased risk of SSI. Early diagnosis and prompt treatment are essential to decrease morbidity and financial burden due to surgical site infection.

Keywords: Acute Appendicitis, Surgical Site Infection, Open Appendectomy

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Introduction

Acute appendicitis is the most common emergency abdominal surgical condition, with a reported incidence of nearly 100 per 100 000 person-years in Europe, Australia, and North America.[1] Though antibiotic therapy may be useful for a certain group of patients with uncomplicated acute appendicitis, appendectomy is also the first-line management for acute appendicitis.[2] SSIs are the most common hospital-acquired infections after surgery that increases overall cost and length of hospital stay and are largely preventable. In the meantime, appendectomy remains a common surgical procedure related to a considerable risk of surgical site infections (SSIs). Surgical site infections (SSIs) occur near or at the incision site and/or deeper underlying tissue spaces and organs within 30 days of a surgical procedure (or up to 90 days for implanted prosthetics).[3] For low-income and middle-income countries, SSI is both the most frequently studied and the leading reported healthcare-associated infection.[4] We aim to identify risk factors for SSI in adults and children who had undergone appendectomy in our setting.

Subjects and Methods

A total of 292 patients who underwent open appendectomy between July 2017 to June 2021 in People's Dental College and Hospital, Kathmandu, Nepal were included. The study was approved by the institutional review committee of People's Dental College and Hospital, Kathmandu, Nepal. We divided patients into two groups based on the occurrence of SSI postoperatively; SSI group and non-SSI group. Patient demographic characteristics and perioperative data were compared between two groups. Patients who had appendectomy for acute appendicitis comprising simple and complex appendicitis were included as inclusion criteria. While exclusion criteria consisted of patients who underwent interval appendectomy (appendectomy after resolution of the acute condition) or appendectomy for another reason (e.g. facecloth of the appendix or chronic appendicitis. Abnormal white blood cell count was measured as less than 4000/mm3 (leukopenia) or more than 11000/mm3 (leukocytosis). Within high white cell counts groups, we divided into two groups based on WCC less or more than 16000/mm3. Temperature above 37.80C was taken as fever. A diagnosis of acute appendicitis was done based on clinical demonstration, and laboratory and radiological results.

After the patient was clinically diagnosed with acute appendicitis, the patient was arranged for an open

appendectomy. All patients received antibiotics third-generation cephalosporin and metronidazole prophylaxis before surgery. The operative approach was performed through Gridiron's incision. Per operative, findings were documented during operation. Complex appendicitis was considered gangrenous or perforated appendicitis and/or the presence of purulent peritonitis (5). Patient's preoperative, operative details, and postoperative outcomes were compared between the groups, and data were analyzed.

Chi-square test was used for categorical values and all continuous variables were compared with t-test. Multivariate analysis (logistic regression) was applied for those variables that were significant for SSI on univariate analysis. All data were analyzed using SPSS version 22.0 for Windows. P value <0.05 was considered statistically significant.

Results

A total of 292 patients who underwent open appendectomy during the study period included 39 (13.4%) patients who developed SSI and 253 (86.6%) patients who did not have SSI postoperatively. Mean ages were 31.8 ±8.08 and 29.7±7.3 in SSI and non-SSI groups respectively. Most of our patients were male (56.4 and 54.2 %) in both groups. Patient's preoperative and periooperative data are presented in Table 1.

Table 1: Patient's demographics and perioperative data

Variable	SSI N=39 (13.4%)	Non- SSI N=253 (86.6%)	P value
Age, (years) Mean + SD	31.8 ±8.08	29.7±7.3	0.409
Sex Male female	 22 (56.4) 17 (43.6)	 137 (54.2) 116(45.8)	0.792
Comorbidity Yes No	 1 (2.6) 38 (97.4)	 13(5.1) 240 (94.9)	0.484
Temperature <38 ≥ 38	 26(66.7) 13(33.3)	 140(55.3) 113 (44.7)	0.184
WBC†(/mm$^{3)}$ ≥ 16000 <16000	 33(84.6) 6 (15.4)	 38(15.0) 215 (85.0)	0.001*
CRP♣ ≥ 65 <65	 21(53.8) 18 (46.2)	 78(30.8) 175 (69.2)	0.005*
Type of Appendicitis complex simple	 23(59.0) 16 (41.0)	 93(36.8) 160 (63.2)	0.003*
Operative time (mins) ≥ 60 <60	 23(59.0) 16 (41.0)	 93(36.8) 160(63.2)	0.008*

Continuous variables are presented as mean), Categorical variables are presented as n (%); †WCC; White cell count; ♣CRP;C-reactive protein, * P; value is significant if < 0.05

There were no differences in diverse preoperative and perioperative variables (>0.05), when we compared these variables in SSI and non-SSI groups except white cell counts, CRP, type of appendicitis, and operative time (<0.005) as shown in Table 1.

Table 3: Association of variables with difficult laparoscopic cholecystectomy.

Variables	Surgical site infection	Univariate analysis	Multivariate analysis
	n=39 (%)	OR,(CI) P value	OR;(CI); P value
Sex (Male)	22 (56.4)	1.042; (0.555-2.162); 0.792	-
Presence of Comorbidity	1 (2.6)	0.499; (0.062-3.821); 0.484	-
CRP♣ (≥ 65)	21 (53.8)	1.747; (1.238-2.464); 0.005*	0.541; (0.221-1.322); 0.178
WCC † (≥ 16000/mm$^{3)}$)	33(84.6)	5.634; (4.082-7.775); 0.001*	0.022; (0.007-0.065); 0.001*
Type of appendicitis (Complex)	23(59.0)	1.715; (1.255-2.344); 0.003*	0.153; (0.056-0.0413); 0.001*
Operative time (≥ 60 mins)	23(59.0)	1.604; (1.179-2.182); 0.007*	0.574; (0.234-1.397); 0.221

OR: odds ratio; CI: confidence interval; †WCC; White cell count; ♣CRP;C-reactive protein,; * P; value is significant if < 0.05

The most common SSI was superficial SSI (11.06%) followed by deep SSI (2.34%). In logistic regression analysis, on multivariate analysis, out of independent variables sex (male), presence of comorbidity, WCC (≥ 16000), CRP (≥ 65), type of appendicitis (complex), and duration of surgery (>60 mins), only WCC (≥ 16000), and type of appendicitis (complex) were associated with an increased risk of SSI (P <0.005) as shown in Table 2.

Discussion

Healthcare related infections are the most frequent adverse event affecting patient safety worldwide and these infections are developed by patients when receiving treatment in the hospital. Open appendectomy is a common surgical operation associated with a significant risk of surgical site infections (SSIs.[6] SSI following appendectomy is a serious postoperative complication that increases the economic problem for both the patient and the healthcare system. Additionally, surgical site infections are among the most preventable healthcare-related infections.

The overall prevalence of SSI after appendectomy was 7.0 per 100 appendectomies varying from 0% to 37.4 %.[7] The main causes of SSI are Staphylococcus aureus, coagulase-negative staphylococci and Escherichia coli. Most of the time SSIs are mainly caused by micro-organisms resistant to usually used antimicrobials, which can be multidrug-resistant.[8]

SSI is classified as superficial incisional those involving skin and subcutaneous tissue and deep incisional SSI those involving deeper soft tissue of surgical incision. Organ/space SSI comprises any part of the anatomy other than incised body wall layers, that was opened or manipulated during an operation.[9]

Patient-associated and procedural-associated factors can cause SSI. These risk factors can be divided into two

categories; non-modifiable factors such as age and sex and modifiable factors including obesity, diabetes, prolonged duration of surgery, nutritional status, tobacco use, lower volume of hospital and surgeons, and intraoperative techniques, correct use of antibiotics, and pre-surgery hospital stay of at least 2 days.[10]

When we analyzed different variables to find the association with SSI, only WCC (≥ 16000), and type of appendicitis (complex) were associated with an increased risk of SSI. A large study from Swetzerland reported lower rates of SSI in patients with non-perforated appendicitis.[12] while another study has shown that a high rate of SSI in complex appendicitis.[13] similar to our study. Time from admission to the operation of more than 6 hours was not associated with the development of SSI in one study.[11] However, a large study by Teixeira et al reported the opposite to this.[14] In our study, however, no information regarding the duration of symptoms is described. Although we did not find out any association between CRP and SSI, a study showed that CRP levels higher than 65 is a risk factor for the development of an SSI.[15]

The WHO reports showing that the prevalence of healthcare-associated infections is two to three times higher in low-income and middle-income countries than in high-income countries.[10] The limited resources for perioperative infection control may be the cause as compared with other countries. The presence of comorbidities and undernutrition might be associated with an increased risk of SSI after appendectomy in low-income settings.[16] Last but not the least, the reason could be that open surgery is the most commonly used surgical procedure in this setting.

A significant consideration is required to limit the problem of SSIs after an appendectomy, and should be focused on policies that can help address factors related to the increased risk of SSIs. The WHO recommendations on preventing SSIs should be circulated and performed.[10] particularly in low-income countries firming the healthcare systems of low-income countries is of the highest importance and might be achieved by educating and giving training to healthcare workers to improve their skills in execution less invasive surgical processes.[7]

We acknowledged the limitations of our study as being a retrospective and single-center study. Henceforth, to authenticate our findings, we endorse appropriately planned prospective studies in our setting in the future.

Conclusion

White cell counts (≥ 16000), and type of appendicitis (complex) were associated with an increased risk of SSI. Early diagnosis and prompt treatment are essential to decrease morbidity and financial burden due to surgical site infection.

Conflict of Interest: None
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