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Incidence and Risk Factors for Post-Appendectomy Emergency Surgical Site Infections

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ABSTRACT

Objective: This study aimed to investigate the incidence and risk factors for surgical site infection (SSI) following appendectomy.
Methods: This retrospective cohort study examined the records of 180 patients who underwent appendectomy in Emam Khomeini Hospital from January 2021 to December 2022. The research tool included a demographic profile form and a research checklist. After obtaining the ethical approval from the university, the researcher visited the hospital and extracted the required data from the patient's clinical file (in accordance with the research checklist). Then, the collected data were entered into SPSS software (version 21) for data analysis.
Results: Of the 180 patient records included in the study, 28 (15.6%) developed SSI. The descriptive analysis revealed that among the patients with SSI, 19 patients were men (67.9%), 18 (64.3%) had a low BMI, 8 (28.6%) had blood type A^-, and 19 (67.9%) patients had a fever below 38 °C. Regarding clinical symptoms, 1 (3.6%) patient had gangrenous appendicitis, and 22 (78.6%) required urgent surgery. Notably, no significant risk factors for SSI were identified. There was no association between SSI status and demographic variables, clinical symptoms, or underlying conditions ($p>0.05$).
Conclusion: The incidence of SSI following appendectomy was relatively higher than in previous studies, though no significant risk factors were identified. Given this, standardization and adherence to evidence-based infection control practices, such as an appropriate preoperative antiseptic preparation, timely administration of prophylactic antibiotics, and the use of laparoscopic techniques when feasible, might help reduce SSI risk.

Keywords: Incidence, Appendectomy, Infections, Emergencies.

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Introduction

Appendicitis is the most common cause of acute abdominal pain requiring surgical intervention. Without timely diagnosis, it can lead to severe complications. Rapid and timely diagnosis is therefore a priority for physicians to make clinical decisions [1, 2].

Although acute appendicitis is a common surgical condition, its variable presentation could challenge even experienced physicians. The diagnosis of acute appendicitis is based on the history, physical examination, laboratory tests, and radiological studies. The initial management of appendicitis is based on clinical manifestations and preliminary laboratory test results, making appendicitis a diagnostically complex process [3-5].

The symptoms of appendicitis often overlap with other medical conditions, complicating early diagnosis, particularly in the initial stages of the disease. Many diseases mimic acute appendicitis, contributing to misdiagnosis [3, 6]. Clinically, typically begins as diffuse abdominal pain with nausea and vomiting, progressing within hours to severe localized pain in the right lower quadrant of the abdomen [7].

Despite advances in clinical diagnostic methods, appendiceal rupture, a critical complication, still occurs due to delayed intervention. As there is no definitive method of prevention for appendicitis, the only appropriate solution is to reduce the morbidity and mortality of the disease through prompt diagnosis before rupture or gangrene develops [8, 9]. More importantly, if appendicitis is not treated, the inflamed tissue of the appendix ruptures, followed by peritonitis and shock, accounting for an important cause of patients' mortality.

Surgical site infection (SSI), particularly post-appendectomy SSI, represents a significant postoperative complication. As one of the most prevalent hospital-acquired infections, SSI contributes to substantially increased healthcare costs, higher readmission rates, and patient discomfort [9, 10]. Established risk factors for SSI include malignancies, malnutrition, smoking, immunocompromised states, and advanced age [11]. Notably, despite postoperative antibiotic use, superficial infection rates remain high in patients with perforated appendicitis.

To our knowledge, no prior studies in Iran have examined SSI incidence and risk factors following emergency appendectomy. This study aimed to investigate the incidence and risk factors for post-appendectomy SSI in Ilam hospitals between 2021 and 2022.

Materials and Methods

This retrospective cohort study analyzed the records of 180 patients who underwent appendectomy at Emam Khomeini Hospital (The only government surgical hospital in Ilam) from January 2021 to December 2022.

The inclusion criteria for the study involved pediatric patients under 18 years of age with complete documentation of their surgical and postoperative course who were hospitalized in Ilam hospitals for appendectomy surgery. The exclusion criteria were cases with incomplete clinical records, evidence of pre-existing infection documented before surgery, and instances of patient death or patient discharge. The determination of previous infection history was based on three sources: the patient's medical documentation, diagnostic tests performed during initial admission, and clinical examination performed by the admitting physician.

A total of 736 records were initially screened. After applying inclusion and exclusion criteria, 180 patient records were eligible for final analysis. Missing data were managed through complete case analysis, and variables with more than 10% missing values were excluded from statistical testing. For variables with fewer than 10% missing data, the affected records were excluded pairwise from the relevant analysis. No imputation methods were applied.

The utilized instruments included a demographic profile form and the checklist adapted from studies by Koumu *et al.,* [12] and Guanche Garcell *et al.,* [13]. The validity and reliability of the checklist in this study were reviewed and approved by the researchers.

The checklist included the following items: Hypertension (Yes/No), diabetes mellitus (DM) (Yes/No), Blood type (A^+, AB, B^+, B^-, A^-, O^+, O^-), Antiseptic used for skin preparation (Yes/No), Duration of the procedure (min), Prophylactic antibiotics (Yes/No), Preoperative shaving (Yes/No), Type of surgery (Laparoscopic/Open), Urgency of the operation (Yes/No), Wound infection category (Clean-contaminated/Contaminated/Dirty), Suppurative (Yes/No), Gangrenous (Yes/No), Perforated (Yes/No), body mass index (High/Normal/Low), fever degree (>37.88 °C,<37.88 °C), asthma (Yes/No), heart diseases (Yes/No) and thyroid disease (Yes/No).

The study was approved by the Ethics Committee of Ilam University of Medical Sciences (IR.MEDILAM.REC.1403.299). To ensure patient confidentiality, all data were anonymized before analysis. Identifiable information, such as names, national ID numbers, and admission codes, was excluded during data extraction. The dataset was stored securely with restricted access, and all analyses were conducted using de-identified data.

Statistical Analysis

Statistical analysis was performed using SPSS software (version 21). Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize the demographic

and clinical characteristics. Associations between categorical variables, including sex, blood type, presence of underlying disease, and SSI status, were examined using the Chi-square or Fisher's exact test. For continuous variables, such as age, duration of surgery, normality was assessed using the Shapiro–Wilk test, followed by Independent samples t-tests or Mann–Whitney U tests as appropriate.

A binary logistic regression was initially planned to assess multiple variables' effects on SSI likelihood; however, due to the absence of statistically significant univariate associations, multivariate analysis was not performed. A p-value of <0.05 was considered statistically significant.

Results

A total of 736 cases were initially reviewed, of which 180 met the inclusion criteria. Among these cases, 28 patients (15.6%) developed SSI. Of these 28 SSI cases, 19 patients (67.9%) were male, 8 (28.6%) had blood type A^-, 18 (64.3%) had low BMI, and 19 (67.9%) presented with fever <37.88 °C (Table 1). Patient exclusions comprised 105 cases with incomplete records, 21 cases with preoperative infections, and 430 cases that failed to meet the inclusion criteria (including age >18 years).

Analysis of clinical symptoms revealed that 1 (3.6%) patient had gangrenous appendicitis, and 22 (78.6%) required urgent surgical intervention (Table 2). Statistical analysis demonstrated no significant association between SSI status and any of the examined variables, including demographic characteristics, clinical symptoms, or underlying diseases (p>0.05). The distribution of underlying diseases among the study population is presented in Table 3.

Discussion

Complications from infections and infectious diseases are widespread and can lead to significant economic and psychological stress for patient and their family members, as well as disease exacerbation and impaired recovery [14-18]. Our findings revealed that 28 (15.6%) of the 180 patients studied developed SSI. Previous studies reported SSI rates ranging from 5.5% and 15.9% [12, 19-21].

Moreover, no association was found between underlying diseases and SSI. Cristian *et al.,* (2006-

Table 1. Demographic characteristics of patients

Variable		With SSI (n=28)	Without SSI (n=152)	*p* value	F
Sex	Male	19 (67.9)	79 (52)	0.122	2.41
	Female	9 (32.1)	73 (48)		
Blood types	A^+	3 (10.7)	19 (12.5)	0.54	0.37
	AB	5 (17.9)	37 (24.3)		
	B^+	7 (25)	31 (20.4)		
	B^-	3 (10.7)	26 (17.1)		
	A^-	8 (28.6)	28 (18.4)		
	O^+	2 (7.1)	5 (3.3)		
	O^-	0 (0)	6 (3.9)		
Body mass index	High	2 (7.1)	13 (8.6)	0.92	0.008
	Normal	8 (28.6)	41 (27)		
	Low	18 (64.3)	98 (64.5)		
Fever	≥37.88°C	9 (32.1)	49 (32.2)	0.99	0.000
	<37.88°C	19 (67.9)	103 (67.8)		

Table 2. Clinical symptoms of patients

Variable/Percentages per group for Yes	With SSI	Without SSI	*p* value
Antiseptics used for skin preparation	22 (78.6)	122 (80.3)	0.83
Prophylactic antibiotics	26 (92.9)	128 (84.2)	0.23
Urgency of the operation	22 (78.6)	95 (62.5)	0.10
Gangrenous	1 (3.6)	5 (3.3)	0.94
Perforated	0 (0)	9 (5.9)	0.18

Table 3. Status of underlying diseases in patients

Variable/ Percentages per group for Yes	With SSI	Without SSI	*p* value
Hypertension	0 (0)	0 (0)	-
Thyroid diseases	1 (3.6)	2 (1.3)	0.39
Heart diseases	0 (0)	0 (0)	-
Asthma	1 (3.6)	4 (2.6)	0.78
DM	4 (14.3)	14 (9.2)	0.41

DM: Diabetes mellitus

2019) examined readmitted patients following laparoscopic appendectomy and found that comorbidities, including coronary heart disease, hypertension, diabetes, and pulmonary disease, did not affect readmission status [22]. This was consistent with our findings showing no association between SSI status and conditions, such as hypertension, thyroid diseases, heart diseases, asthma, and DM.

Furthermore, no significant relationship was observed between sex/BMI and the incidence of SSI. In the study by Guanche Garcell *et al.,* which was parallel with this study, there was no relationship between sex and BMI and the SSI incidence. In the group with SSI, 29 patients were male, while in the non-SSI group, 950 patients were male, and 49 patients were female [13]. In contrast, in the study by Saadun *et al.,* (n=320), there was no relationship between the patient's sex and SSI status; however, a significant relationship was observed between SSI and BMI. Their SSI group comprised 20% obese, 37.14% overweight, and 42.86% normal status. While in the group without SSI, 7.37% were obese, 15.09% were overweight, and 71.58% were in the normal status [20].

Our findings showed no difference in SSI rates between patients with gangrenous versus perforated appendicitis. In the study of Salman *et al.,* (n=292), the SSI group included 10 cases of gangrenous appendicitis and 2 perforations, while the non-SSI group had 28 gangrenous cases and 10 perforations [21]. Similarly, Koumu *et al.,* (n=433) reported 9 perforations in the SSI group versus 36 in non-SSI patients (a significant difference), while gangrenous findings showed 2 SSI cases versus 24 non-SSI cases (non-significant) [12].

In this study, the SSI rate was 15.6%, which was higher than some reported rates (Mahmood *et al.,* 5.5%), while comparable to others (Koumu *et al.,* 7.2%). Several factors might explain this variation. First, our study population included a higher proportion of emergency surgeries, which carried increased infection risk due to reduced preoperative optimization. Second, regional differences in hospital infection control practices, perioperative antibiotic protocols, and surgical techniques (particularly the rate of open vs. laparoscopic procedures) might contribute to varying SSI rates. Moreover, the absence of statistically significant associations between SSI and potential risk factors in our study might reflect methodological limitations, such as small sample size and low statistical power, particularly in subgroup analyses (e.g., blood type comparisons). In contrast, larger-scale or multi-center studies (e.g., Guanche Garcell *et al.,*) might identify associations that are not detectable in our dataset. Lastly, the retrospective nature of data collection introduced heterogeneity in documentation and potential underreporting of clinical variables, such as comorbidities or fever, which could affect statistical outcomes.

Although no statistically significant predictors of SSI were identified, these findings remained clinically relevant. The observed SSI rate of 15.6% suggested that clinicians should maintain vigilance for postoperative infections, particularly following emergency appendectomies. Strict adherence to surgical asepsis, timely administration of prophylactic antibiotics, and preferential use of laparoscopic approaches when feasible might help mitigate the SSI risk. In addition, this study underscored the importance of comprehensive documentation and surveillance systems, especially in settings with limited resources, to enable early detection and intervention in potential SSI cases.

This study had several limitations that should be considered when interpreting the findings. First, the relatively small sample size (n=180) and particularly the low number of SSI cases (n=28) might have limited statistical power to detect significant associations between risk factors and infection outcomes. Consequently, some potential relationships might have remained undetected due to insufficient sample size rather than representing true null effects. Second, the retrospective design was inherently limited by the availability and completeness of medical records, with possible underreporting or inconsistent documentation of non-mandatory clinical findings and comorbidities. Additionally, as a single-region study conducted in Ilam hospitals(Emam Khomeini Hospital), the results might have limited generalizability to other populations and healthcare settings. Future research employing larger, multi-center cohorts and prospective designs would help validate these findings and better identify modifiable SSI risk factors following appendectomy.

Our findings revealed a relatively high SSI rate following appendectomy despite the absence of statistically significant associations with demographic or clinical factors. These results highlighted the critical need to prioritize modifiable perioperative measures, including strict application of preoperative skin antiseptics, adherence to prophylactic antibiotic protocols, minimization of surgical duration, and preferential use of laparoscopic approaches when clinically appropriate. Further prospective studies are recommended to more precisely investigate patient- and procedure-related factors that might effectively minimize the SSI risk.

Declaration

Ethics approval and consent to participate: The study was approved by the Ethics Committee of Ilam University of Medical Sciences (IR.MEDILAM.REC.1404.003)

Consent for publication: All authors expressed their consent to the publication of this study.

Conflict of Interest: The authors declared that there was no conflict of interest.

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Authors' Contribution: All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed, and a draft of the manuscript was written, based on previous versions of the manuscript. All authors read and approved the final manuscript.

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