

Original Research Article

Frequency of surgical site infection after single dose of preoperative antibiotics in children with uncomplicated acute appendicitis: a cross-sectional study

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ABSTRACT

Background: Hyperaemic suppurative appendicitis, or uncomplicated appendicitis, often requires an appendectomy. Surgical Site Infection (SSI) is common post-surgery, and prophylactic studies show ceftriaxone and metronidazole effectively protect against most causative organisms.

Methods: Ninety patients were included through non-probability convenience sampling. Acute appendicitis was diagnosed using the Alvarado score, with surgery for scores of 7 or higher. A single preoperative dose of ceftriaxone and metronidazole was administered. Follow-up visits included stitch removal on the seventh postoperative day and monitoring up to the tenth postoperative day using the Southampton criteria for wound infection.

Results: Of the 90 patients, 64 (71.1%) were male and 26 (28.9%) were female. Fifty (55.6%) scored 7-8 on the Alvarado score, and 40 (44.4%) scored 9-10. Using the Southampton criteria, 5 (5.6%) developed grade I SSI. Infection rates showed no significant difference between male (3.1%) and female (11.5%) patients (p value >0.05) or by Alvarado score and symptom duration. No cases of SSI beyond grade II were observed.

Conclusions: Administering a single preoperative antibiotic dose effectively minimizes surgical site infection in children with uncomplicated acute appendicitis, demonstrating clear management advantages.

Keywords: Surgical site infection, Hyperaemic suppurative appendicitis, Alvarado score

INTRODUCTION

Appendicitis is a frequently observed acute surgical condition affecting the abdominal region in children¹. Its occurrence rate is generally stated as 1 per 1000 children annually. Approximately one third of appendicitis cases involve patients under the age of 18. The highest frequency of occurrence is typically seen in the 11–12-year age group. While appendicitis is rare in infants, it is important to note that even premature infants can experience perforated appendicitis. Each year, approximately 60,000 to 80,000 pediatric appendectomies are performed, with an average cost of

around \$9,000. Appendicitis is relatively infrequent in very young children, with preschool-aged children comprising only 5% of cases. Moreover, there is a higher occurrence of appendicitis in males, accounting for 55% to 60% of cases.⁹

The primary basis for diagnosing acute appendicitis relies on clinical symptoms, although imaging techniques such as ultrasound and CT scan can provide valuable assistance. Various scoring systems, such as the Alvarado scoring and pediatric appendicitis score, have been created to assist in diagnosing acute appendicitis. Abdominal computed tomography (CT) is particularly

effective in providing a precise diagnosis of appendicitis due to its high specificity, with a sensitivity of over 98% and specificity of 80%. However, it is important to consider the potential risk of radiation exposure associated with CT scans.² Even with advanced diagnostic imaging methods accessible, accurately diagnosing acute appendicitis in young children continues to pose difficulties. This is primarily since many of these patients present late, often with complications such as perforation that can result in abscess formation, generalized peritonitis, and sepsis. Uncomplicated appendicitis, known as hyperaemic suppurative appendicitis, represents a common stage among patients diagnosed with appendicitis. Suppurative appendicitis is a pathological term that refers to inflammation without gangrene.³ While antibiotics are increasingly utilized as the main definitive treatment for specific patients with uncomplicated acute appendicitis, appendectomy is still regarded as the preferred and most effective therapeutic approach.⁴ However, in cases where antibiotics were not administered prior to surgery for acute appendicitis, a reported incidence of over 25% for wound infections has been observed.⁵ The administration of antibiotics before surgery is recognized as an effective measure for reducing infectious complications following appendectomy. However, despite advancements in perioperative care and antibiotic usage, surgical site infection (SSI) remains the most prevalent complication after the operation. The anticipated incidence of wound infection in cases of uncomplicated acute appendicitis, with the use of a single preoperative antibiotic dose, is 9.1%.⁶

In early childhood, the presentation of appendicitis is often atypical, making the diagnosis more challenging.⁷ Additionally, children in this age group have limited communication skills, which can lead to misunderstandings regarding the disease. The diverse clinical manifestations observed across different age groups can be attributed to anatomical variations and variations in the underlying pathophysiology of acute appendicitis. The estimated lifetime risk of developing appendicitis ranges from 7% to 9%.⁸ These factors are a significant concern for clinicians and highlight the importance of thorough investigation in order to establish an effective management protocol for such patients.^{9,10} Within the first 28 days of life, luminal obstruction is not the typical cause of the condition. Instead, neonatal acute appendicitis is more likely to be caused by factors such as ischemia resulting from embolic or thrombotic events, obstructed internal or external hernia, cardiac anomalies, and distal colonic obstruction, as seen in Hirschsprung's disease. Pain and nausea, which are common indicators of acute appendicitis in older patients, may not be reliable signs in neonates. Healthcare-associated infections are contracted by patients during their medical treatment and represent the most common adverse event that compromises patient safety globally. Among these infections is SSI following an appendectomy, which has been identified as the predominant infection in hospitals

across developed nations. Irrespective of the surgical approach used (laparoscopic or open surgery), appendectomy remains a procedure with considerable risk of SSIs.¹¹ Recent studies have demonstrated that using newer, broad-spectrum drugs like piperacillin/tazobactam alone for intra-abdominal infections is just as effective as the traditional triple therapy. Likewise, cefotaxime, a cephalosporin similar to ceftriaxone, has been found to be as effective as the aforementioned piperacillin/tazobactam monotherapy when combined with metronidazole in children with complicated perforated appendicitis. Monotherapy appears to offer more benefits compared to a dual treatment approach.¹² It has been shown that ceftriaxone and metronidazole provide comprehensive coverage for most enteric organisms in prophylactic studies as well as traumatic and surgical contamination studies.¹³ This study aimed to assess the effectiveness of administering a single dose of antibiotics half an hour before surgery in uncomplicated acute appendicitis cases in children. The objective was to evaluate the outcomes, specifically in terms of wound infection and other post-operative complications, as different medical centres have varied approaches to postoperative antibiotic treatment methods.

METHODS

This is a descriptive case series conducted in the Department of Paediatric Surgery, Shaikh Zayed Hospital, Lahore over a period of 12 months from March 13, 2023 till March 12, 2024. A total of 90 patients were selected using non-probability convenience sampling. Both Males and Females below the age of 14 who were diagnosed with uncomplicated acutely inflamed appendix with clinical and radiological evidence. Patients who underwent an incidental appendectomy, had Hepatitis B and C, or were diagnosed with any other concomitant illness including but not limited to any immunocompromised states, malignancy or any hematological disorders were excluded from the study. The Alvarado score was used to confirm the diagnosis of acute appendicitis. Patients with a score of 7 or higher underwent surgery, while those with a score between 4 and 6 were reevaluated clinically and, if necessary, underwent an ultrasound. Surgery was performed if the diagnosis was confirmed upon reevaluation. Prior to surgery, patients provided written informed consent, and a single dose of preoperative antibiotics, as specified in the defined criteria based on patient weight, was administered half an hour before anesthesia induction. The operative procedure was carried out in a supine position under general anesthesia, following aseptic measures. Appendectomy was performed using the standard Lanz incision method, and the wound was closed using simple interrupted sutures with polypropylene 3/0. Patients were discharged on the third day after surgery, with careful observation of surgical site complications as outlined in the provided form. During follow-up visits at the outpatient department, skin stitches were removed on the seventh postoperative day, and

complications were monitored up to the tenth postoperative day using the Southampton criteria for wound infection. SSI were documented according to the defined criteria. Acutely inflamed appendix was defined as a hyperemic and suppurated appendix without perforation or gangrene, as assessed during the operation, in patients with an Alvarado score of ≥ 7 out of 10. Patients were considered to have a surgical site infection if there were indications of bruising, swelling, erythema, and discharge observed on the surgical site at 3, 7, and 10 days after the surgery, based on the Southampton criteria. Any grade 1 or higher infection during the follow-up period was also considered. Intravenous administration of Ceftriaxone at a dosage of 50 milligrams per kilogram and Metronidazole at a dosage of 7.5 milligrams per kilogram per dose was given according to the patient's weight.

Data analysis

The data was inputted and analyzed using SPSS software version 20. Descriptive statistics, such as mean and standard deviation, were used to describe the age data, while frequency and percentages were used to describe the gender. The data was then stratified based on age, gender, duration of symptoms, and Alvarado Score. Post stratification, a chi-square test was applied to examine the association, with a significance level of $p \leq 0.05$ considered statistically significant.

RESULTS

During the designated study period, a total of 90 patients who met the inclusion criteria were included. Among them, 64 (71.1%) were male and 26 (28.9%) were female. The average age of the patients was 9.12 ± 2.31 years, ranging from 5 to 13 years. The patients were categorized into two groups based on their age, with 38 (42.2%) falling within the 5–8-year range and 52 (57.8%) falling within the 9–13-year range. No patients were withdrawn from the study, and there were no reported deaths during the study period. Of the cases, 51 (56.7%) exhibited symptoms and signs of acute appendicitis for less than 1 day, while 39 (43.3%) experienced symptoms for more than 1 day. The Alvarado score was calculated for all patients, with 50 (55.6%) having a score of 7-8 and 40 (44.4%) having a score of 9-10. Assessment of surgical site infection (SSI) was conducted using the Southampton criteria, revealing that 5 (5.6%) cases developed grade I SSI. Among these cases, 2 (3.1%) were male and 3 (11.5%) were female. All these patients experienced fever up to 100°F on the second postoperative day, for which an additional two doses of intravenous antibiotics were administered. They were discharged on the third postoperative day without a prescription for antibiotics. Grade 1 SSI was observed on the seventh postoperative day. The frequency of infection was found to be statistically similar between the 5–8-year age group (7.9%) and the 9–13-year age group (3.8%) ($p > 0.05$). The frequency of infection was also similar

between male (3.1%) and female (11.5%) cases ($p > 0.05$), as well as with respect to Alvarado score and duration of symptoms. No patients experienced SSI beyond grade II.

Table 1: Descriptive statistics of age (years).

Age (years)	
Mean	9.12
S.D.	2.30
Range	8
Minimum	5
Maximum	13

Table 2: Comparison of infection and age groups (years).

Variables		Infection (%)		Total (%)
		Yes	No	
Age (years)	5-8	3 (7.9)	35 (92.1)	38 (100)
	9-13	2 (3.8)	50 (96.2)	52 (100)
Total		5 (5.6)	85 (94.4)	90 (100)

Chi-square=0.686; P value=0.408

Bleeding per rectum 80%, weight loss 60%, anemia 60% and altered bowel habits 77.13 % were the presenting symptoms. All patients were subjected to biopsy or fine needle aspiration cytology and the diagnosis confirmed. Other investigations done are ultrasonography, barium enema, CT scan, CEA etc. Figure 1 represents the various surgical management.

Descriptive Statistics for Infection

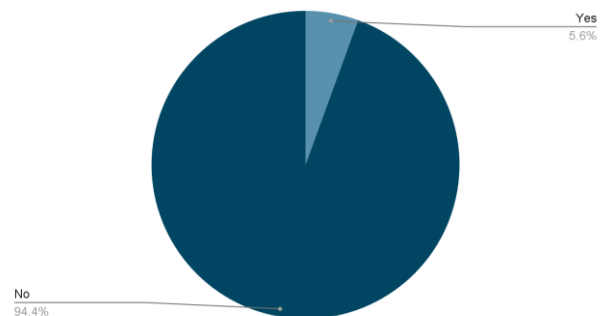


Figure 1: Descriptive statistics of infection.

Table 3: Comparison of infection and gender.

		Infection (%)		Total (%)
		Yes	No	
Gender	Male	2 (3.1)	62 (96.9)	64 (100)
	Female	3 (11.5)	23 (88.5)	26 (100)
Total		5 (5.6)	85 (94.4)	90 (100)

Chi-square=2.49; P value=0.114 (Insignificant)

Commonest site for metastasis was regional lymph node. 8 patients had secondary deposits in liver, 2 were having

deposit in anterior abdominal wall and two females were having secondary deposits in both ovaries.

Table 4: Comparison of infection and duration of symptoms.

		Infection (%)		Total (%)
		Yes	No	
Duration of symptoms (days)	<1 day	4 (7.8)	47 (92.2)	51 (100)
	1 day or more	1 (2.6)	38 (97.4)	39 (100)
Total		5 (5.6)	85 (94.4)	90 (100)

Chi-square=1.17, P value = 0.279 (Insignificant)

Table 5: Alvarado score.

		Infection (%)		Total (%)
		Yes	No	
Alvarado score	7-8	2 (4)	48 (96)	50 (100)
	9-10	3 (7.5)	37 (92.5)	40 (100)
Total		5 (5.6)	85 (94.4)	90 (100)

DISCUSSION

Prescribing antibiotics before surgery is widely believed to be effective in minimizing the risk of infectious complications associated with appendectomy. Consequently, most surgeons administer antibiotics to patients diagnosed with appendicitis prior to the operation. However, the recommendation for antibiotic prescription within the initial 24 hours after surgery is primarily limited to cases of complicated appendicitis, and there remains a debate surrounding its necessity and effectiveness.¹⁴ Anaerobic bacteria constitute 60% of the microflora found within the inflamed appendix, whereas only 25% of the luminal contents in a healthy appendix consist of anaerobic microorganisms. It is important to note that appendicitis is characterized by a polymicrobial infection, involving the presence of multiple types of microorganisms.¹⁵ Aerobic flora of the skin alone or with other pathogens lead to a high percentage of surgical site infections. Moreover, gram-negative enteric bacteria are the most probable reasons of wound infection after appendectomy. Cephalosporin has an extended spectrum of anti-bacterial effect against gram-positive cocci and gram-negative enteric bacteria and are the most commonly utilized antibiotics in prophylaxis and treatment. There is controversy regarding type of prophylactic antibiotics for appendectomy surgery. Some believe that Cefoxitin and Cefotetan are sufficient and some suggest Cefazolin plus metronidazole or Gentamicin plus metronidazole or clindamycin plus metronidazole are best.¹⁶ In the current study the mean age of patients was 9.12 ± 2.31 years with minimum and maximum age as 5 and 13 years. There were 64 (71.1%)

male and 26 (28.9%) female cases which shows that appendicitis is more common in males.

In our study 5 (5.6%) cases who had surgical site infection. Our findings show less percentage of infection than Khalifani et al who reported cases of acute appendicitis that have not received antibiotics before surgery over 25% wound infection.⁵ Molaginan et al reported that post-operative wound infection in 5% of total study subjects. Hence, incidence of post-operative wound infection was 5%. They concluded that in patients undergoing appendectomy for non-perforated appendicitis, single dose preoperative antibiotics were efficacious in preventing post-operative wound infection.¹⁷ Another study done on the adult population reported that in group in which pre and postoperative antibiotics were given, the total number of patients was 245 (50.8%), in which 20 (4.1%) developed wound infection. The overall wound infection rate was 7.6 % (37 patients out of 482).¹⁸ Likewise, a local study was performed to evaluate the role of postoperative antibiotics in reducing surgical site infections after appendectomy for non-perforated appendicitis. Number of surgical site infections was 15(7.8%) in Group A and 18(9.1%) in Group B ($p=0.65$). Mean hospital stay of 3.32 ± 0.4 days and 3.59 ± 0.46 days was observed for Group A and B, respectively, ($p<0.001$). So, the study concluded that A single pre-operative dose of cefuroxime and metronidazole had the same efficacy in preventing surgical site infections in cases of non-perforated appendicitis as when the same regimen was repeated postoperatively.¹⁸ Another local observational study was performed in 2015 to see the frequency of wound infection in non-perforated appendicitis with single dose preoperative antibiotics only. Prophylactic antibiotics were found efficacious in 114 (94.21%) patients. There was no significant association between wound infection regarding age and gender in this study conducted at Abbottabad, Pakistan. Our study also had the similar results. Hence, Single dose preoperative antibiotics were found effective in controlling post-operative wound infection without the need of extending the antibiotics to post-operative period in cases of non-perforated appendicitis.¹⁹ In 2012, a Randomized controlled trial was done to determine the role of postoperative antibiotics in reducing the surgical site infections (SSIs) after open appendectomy in patients with non-perforated appendicitis (NPA) at the Department of Surgery, King Saud Medical City, Riyadh, Kingdom of Saudi Arabia, from January 2010 to July 2011. 377 patients, who underwent appendectomy for NPA and fulfilled the selection criteria, were randomized into two groups. The patients in group A received a single dose of pre-operative antibiotics (cefuroxime sodium and metronidazole), while the group B patients received one more dose of the same antibiotics postoperatively. Patients of both the groups were followed-up for 30 days to assess the postoperative infective complications. The study result has showed that Group A had 195, while group B comprised of 182 patients. The groups were

comparable in the baseline characteristics. Statistically there was no significant difference in rates of SSIs between both the groups ($p=0.9182$). Mean hospital stay was 2.29 ± 0.81 and 2.35 ± 0.48 days for group A and B respectively ($p=0.4403$). None of the patients developed intra-abdominal collection. So, Single dose of pre-operative antibiotics (cefuroxime and metronidazole) was sufficient in reducing the SSIs after appendectomy for NPA. Postoperative antibiotics did not add an appreciable clinical benefit in these patients.²⁰

Further another study aimed to determine the effectiveness of a single-dose antibiotic prophylaxis in prevention of surgical site infection in open appendectomy of non-perforated acute appendicitis. A single blind randomized controlled trial in 110 non perforated acute appendicitis patients that underwent open appendectomy at Single General Hospital emergency operating theatre from April to June 2012 was conducted. Cefazolin 1 g and Metronidazole 500 mg were administered intravenously prior to surgery. Samples were divided into two groups by permuted block. Risk of SSI in single-dose group was 7.3% and multiple-dose group was 5.5% with relative risk (RR)=1.33% (95% CI RR: 0.31-5.68, $p=1.000$), in comparison to our single group observational study where all the patients were given single dose prophylactic antibiotic pre-operatively and the risk of surgical site infection was found to be 5.6%. Hence, there is no difference of SSI risk between single and multiple-dose antibiotic prophylaxis in open appendectomy of non-perforated acute appendicitis.²¹ Similarly, another study was done to examine risk factors, use, and efficacy of prophylactic antibiotics for surgical site infection SSI among patients with uncomplicated open appendectomy. Ninety-two percent of all patients (95% CI, 91.0–93.3) received antibiotic prophylaxis. Metronidazole and gentamicin were the two most common antibiotic agents, with a combined single dose administered in 39% of cases, as compared to our study where all the patients meeting inclusion criteria were given ceftriaxone and metronidazole as single shot antibiotic preoperatively. In 54% of cases, antibiotic prophylaxis was administered for one day. The authors found that a prolonged duration of operation was significantly associated with an increased SSI risk. In this study conducted in Thailand, antibiotic prophylaxis was significantly associated with a decreased risk of SSI regardless of whether the antibiotic was administered preoperatively or intraoperative versus no antibiotic prophylaxis, as compared to our study where antibiotics were only given preoperatively. SSI relative risks for combined single-dose of metronidazole and gentamicin, one-day prophylaxis, and multiple-day antibiotic prophylaxis were 0.28 (0.09–0.90), 0.30 (0.11–0.88) and 0.32 (0.10–0.98), respectively. Thus, Single-dose combination of metronidazole and gentamicin seems sufficient to reduce SSIs in uncomplicated appendicitis patients despite whether the antibiotic was administered preoperatively or intraoperative 22 and in our study single-dose combination of ceftriaxone metronidazole

was sufficient in reduction of surgical site infection post-operatively.

This study has limitations including selection bias from non-probability convenience sampling and a small sample size of 90 patients, which affects the statistical power. The short follow-up period of ten days may miss late-onset infections, and as a single-center study, the results may not be widely applicable. The absence of a control group complicates attributing low SSI rates to the antibiotic protocol. Uncontrolled variability in surgical techniques and reliance on the Alvarado score for diagnosis, which may miss atypical cases, also pose issues. Lastly, the lack of detailed demographic and clinical data limits control over confounding factors affecting SSI risk.

CONCLUSION

Based on the findings, it can be inferred that the occurrence of surgical site infection following a single preoperative antibiotic dose in children with uncomplicated acute appendicitis is very low. Therefore, the use of preoperative antibiotics proves beneficial in managing infections. Additionally, it is important to investigate other contributing factors to infections in order to minimize associated costs and readmission rates.

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