MHA MEDIHEALTH ACADEMY

Surgery on Children

Original Article

doi: 10.51271/SOC-0041

Evaluation of our post-appendectomy management protocol

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Received: 31/12/2024 ◆ **Accepted**: 18/03/2025 ◆ **Published**: 01/07/2025

Cite this article: İbrahim AA, Rayes TE, Abbas TO, Al Romaihi SA, Ali MA. Evaluation of our post-appendectomy management protocol. *Surg Child*. 2025;2(3):82-86.

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ABSTRACT

Aims: Many post-appendectomy treatment protocols have been created and modified, but none were aspiring to be the best in pediatric surgery. In 2008 Shawn et al, standardized the definition of perforated appendix to be only when you see a hole in the appendix or a fecolith in the peritoneal cavity1; We continued the definition and set a new treatment protocol accordingly.

Methods: It is a retrospective study for the age group 0 to 14 years old. The Treatment protocol was created and applied in 2012. We have created two groups (100 patients in each group). First group from 2010 - 2011 and second group from 2013-2014. The treatment in the first group is clinical and empirical. In the second group the treatment depended on a designed criteria matching our protocol.

Results: There was no statistical significance regarding the post-operative collection (5 patients in the 1st group and 4 patients in the 2nd group), mean length of hospital stays (4.57 in the 1st group and 5.30 in the 2nd group), emergency visits (5 visits in each group), and finally hospital re-admission (1 in the 1st group and none in the 2nd group).

Conclusion: There was a clinical significance but no statistical significance between the two groups. Only 4 patients in the 2nd group and 5 patients in the 1st group developed post-appendectomy collection. The re-admissions in the 2nd group were not related to surgery. The antibiotic cost is almost the same, although the number of perforated appendices is higher in the second group. Furthermore, we recommend our protocol for safe patient discharge, especially after complicated appendicitis operations.

Keywords: Appendicitis, collection, antibiotics

INTRODUCTION

Acute appendicitis being the most common emergency condition in pediatric surgery, there appears to have no consistency on the management protocol.[1] Numerous researchers sought to find the most effective outcome with the least morbidity rate using various diagnostic algorithms and different antibiotics.[2,3] Many protocols had been created and modified, but none were aspiring to be the best in pediatric surgery. In 2008 Shawn et al.[1], standardized the definition of perforated appendix to be only when you see a hole in the appendix or a fecolith in the peritoneal cavity. Their outcome was improved after the application of the definition of perforation but not to a great extent.[1] We decided to extend the definition and set a treatment protocol accordingly. Various surgeons decided on the duration of post-appendectomy antibiotics based purely on the clinical findings, in turn they stopped the antibiotics and discharged patients home when the child was afebrile, able to tolerate feeding and pass a bowel motion. Their decisions led to the flaring up of post-appendectomy infections due to inadequate treatment in some cases.[4] Because there was no agreement about the appendicitis treatment, we tried to hold onto these cases early on before they were discharged to avoid potential future complications. In 2012 Holcomb and Shawn[2] studied optimal antibiotic regimen and the length of antibiotic therapy, in 2015 Farach et al.[5] published a study in which they found that operative findings are a better predictor of resource utilization in pediatric appendicitis, and this aligns with our protocol which employed more precautions in order not to miss early post-appendectomy abscess formation.

Objective

We analyzed the management outcome in two post-appendectomy groups retrospectively before and after the implementation of our treatment protocol according to the new intraoperative appendicitis definitions, regarding primary objectives which are length of hospital stay (LHS,

Days) and the incidence of post-appendectomy abscess formation. Additionally, we aimed to identify other variables like the incidence of wound infections, re-admissions within the 1st month after the initial appendectomy and the in-hospital intravenous antibiotic charges (US$).

METHODS

The study was conducted with the permission of the Medical Research Centre HMC Ethics Committee (Date: 10.08.2021, Decision No: MRC-01-21-446). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

We used a retrospective cohort study; our age group is 0 to 14 years old. All cases were done by laparoscopy, and the converted cases are not included in the study. C-reactive protein (CRP) and CBC are being done as a routine blood tests for all the cases with abdominal pain in the emergency department as a baseline before admission to the hospital. We studied the post appendectomy treatment before and after the application of our designed treatment protocol which was applied in 2012. We created 2 groups, one before and one after 2012, we avoided the year 2012 because of the overlap period. The sample size was calculated with the help of our medical research center (MRC).[6] The sample size collection identified the required number would be 89 patients to identify statistical significance. Nevertheless, we collected 100 patients in each group. Our MRC statistician based the sample size calculation on Shawn et al.[1] study. The sample size was determined on the primary outcome variable length of stay (days) reported in the literature: with effect size 1.2, standard deviation of the change in the outcome 3.5, statistical power 90% and level of significance 5%, the required sample size would be n=89 cases. However, to account for multiple secondary outcome measures such as dropouts and non-responses, it was good to increase an additional 30% in the calculated sample size i.e., a total of 200 participants divided equally into two groups will be included in this study. The following sample size equation was used[6]:

The standard normal deviate for α=Zα=1.960,
The standard normal deviate for β=Zβ=1.282,
A=1.000,
B=(Zα+Zβ)2=10.507,
C=(E/S(Δ))2=0.118,
AB/C=89.39,
Group size N: 89,

In the first group, post-appendectomy treatment including antibiotics duration was empirical and it differed between each surgeon. It was dependent on the clinical picture (presence of fever, tolerance of feeding, abdominal pain, and presence of diarrhea).

The protocol of group 2 is guided by the preoperative white cell count (WBC), CRP, and intraoperative classification (**Table 1**). Our antibiotic regimen adheres to our local Institution of Infection Control Guideline standards. The first-line antibiotics are ceftriaxone and metronidazole, the duration of which was established by our intraoperative new classification.

Table 1. Intra-operative classification of the appendix

Appendix type	Description
Normal	No signs of inflammation
Inflamed	Swollen, congested
Severely inflamed	Inflamed with pyogenic membranes or pus in the peritoneal cavity (localized or generalized)
Perforated	When there is a hole in the appendix or a fecolith in the peritoneal cavity

In the second group (**Figure 1**) our new protocol strictly classified appendicitis into 3 categories (**Table 1**); Normal and inflamed, severely inflamed and perforated according to the intraoperative findings.

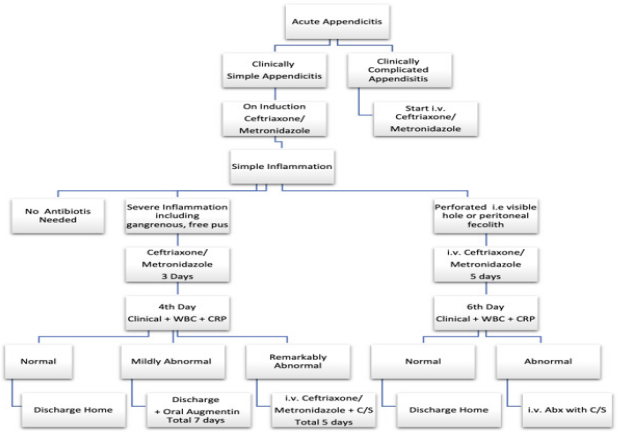

Figure 1. The post-appendectomy antibiotic treatment based on intraoperative classification with the aid of CRP and WBCs
i.v.: Intravenous, WBC: White blood cell, CRP: C-reactive protein, C/S: Culture and sensitivity, Abx: Antibiotics

Normal appendix meant the peritoneal cavity is clean and no local signs of inflammation in the appendix. Just inflamed appendix meant the peritoneal cavity is clean, and the inflammation was confined to the appendix only (**Figure 2A**); these patients received a single dose of antibiotics upon induction of anesthesia. Severely inflamed meant inflamed appendix with the presence of pyogenic membranes (**Figure 2C**) or pus (**Figure 2B**); these patients received 3 days of antibiotics starting upon induction of anesthesia, and before discharge we repeated the CRP and WBCs then we followed up according to the CRP and WBCs results (**Figure 1**). The perforated appendix meant inflamed appendix with the presence of a hole in the appendix (**Figure 2E**) or a fecolith (**Figure 2D**) in the peritoneal cavity; these patients received 5 days of antibiotics starting upon induction of anesthesia, before discharge (Morning of the 6th post-operative day) we repeated the CRP and WBCs then we followed according to the CRP and WBCs results (**Figure 1**).

RESULTS

A total of 200 patients were collected, 100 patients before applying the treatment protocol (group 1) and 100 patients after employing the protocol (group 2) (**Table 2**). The number of males was 140 (66 in the first group and 74 in the second group, total being 70%) while the females were 60 (34 in the first group and 26 in the second group, total being 30%).

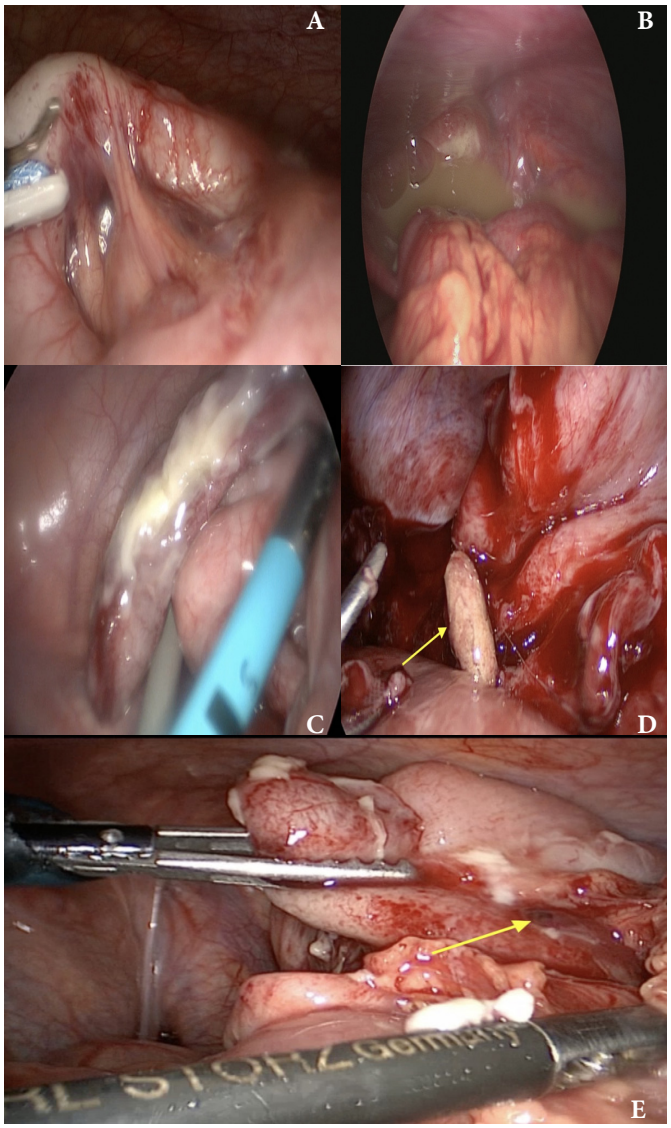

Figure 2. Intraoperative classification of the appendix. **2A.** Inflamed appendix, **2B.** Pus in the pelvis, **2C.** Severely inflamed appendix with pyogenic membranes, **2D.** Fecolith in the peritoneal cavity, **2E.** Perforation in the appendix (arrowed)

Table 2. The frequency of different variables

Variable	First group	Second group	p value
Sex: Male	66	74	0.217
Female	34	26	0.280
Age (mean)	8.99	8.95	0.918
Length of hospital stay (mean)	4.57	5.30	0.050
LOS (median)	4.0	5.0	0.015
Intraabdominal collection	5	4	0.733
Wound infection	1	2	1.000
Re-admission (1st month)	1	0	1.000
Emergency visits	5	4	0.733
Antibiotic charges (US$, mean)	180	228	0.034
Antibiotic charges (US$, median)	144	240	0.001
Histopathology: Normal	8	1	0.000
Inflamed	27	51	0.019
Suppurative	60	36	0.000
Perforated	5	12	0.000

US$: United States Dollar

The total number of post operative intra-abdominal collections (Abscess formation) is 9, where there were 5 in the first group and 4 in the second group (Table 2). There was no significant statistical difference between group 1 and group 2 as regard the risk of developing a post appendectomy intraabdominal collection (p=0.733) OR=0.792 (95% CI 0.206 to 3.039). Regarding the LOS, group 1 had shorter mean length of hospital stay than group 2 (4.57 versus 5.3 days). The one-sided t-test showed a marginally significant statistical difference between the two groups-0.73 days (95% CI-1.6 to 0.14) (p=0.05). Regarding the antibiotic charge, group 1had a lower mean antibiotic charge compared to the group 2 (180.96 versus 228.06 USD). The one-sided t-test showed a marginally significant statistical difference between the two groups -47.10 USD (95%CI-97.74 to3.54). Finally, hospital re-admission was 1 in the 1st group and none in the 2nd group (Table 3).

Table 3. Statistical analysis for the LHS and antibiotic charges

		Age (years)	LHS (days)	Abs (charge US$)
Age (years)	Pearson correlation	1	-.200**	-.218**
	Sig. (2-tailed)		0.005	0.002
	n	200	200	200
Length of hospital stay (days)	Pearson correlation	-.200**	1	.974**
	Sig. (2-tailed)	0.005		0.000
	n	200	200	200
Abs (charge US$)	Pearson correlation	-.218**	.974**	1
	Sig. (2-tailed)	0.002	0.000	
	n	200	200	200

** Correlation is significant at the 0.01 level (2-tailed). US$: United States Dollar, Abs: Antibiotics, LHS: Length of hospital stay

DISCUSSION

Although acute appendicitis is the most frequent emergency condition in pediatric surgery, unfortunately there is no standard protocol for its management. Surgeons around the world classify patients with complicated appendicitis using a variety of criteria and categories. The absence of a standardized definition of perforated appendicitis is responsible for the large variation in reported perforation rates and discrepancies in postoperative abscess rates among individuals with perforated appendicitis. Surgeons use terms such as purulent, perforated, gangrenous, necrotic, ruptured, contained-perforated, and degrees of peritonitis for which there is no evidence, additionally, they represent the same entity. Recent research on this subject revealed a dramatic spectrum for perforation, ranging from 20% to 76%.[7] Furthermore, several surgeons make these diagnoses based on their general clinical impressions, as opposed to the objective criteria. American Pediatric Surgical Association (APSA) members were surveyed in 2000, and the majority reported basing their practice approaches on personal preferences.[8]

Exercising various diagnostic algorithms and antibiotics[2], numerous researchers attempted to discover the optimal

method for achieving a favorable outcome with minimal morbidity. Numerous protocols had been developed and modified, but none stood out as the most effective in pediatric surgery. In 2008, Shawn et al.[1] standardized the definition of a perforated appendix to include only the presence of an appendix perforation or a peritoneal fecolith. Appropriately, we decided to expand the definition and establish a new treatment protocol. Numerous surgeons determine the duration of post-appendectomy antibiotics based solely on clinical findings, so they were discontinuing antibiotics and releasing patients when they were afebrile, and they were able to consume and have bowel motion. In some cases, this led to the worsening of post-appendectomy infections caused by such inadequate treatment. As there was no consensus regarding the treatment of appendicitis, we attempted to identify these cases early to avoid potential complications. In 2012, Holcomb and Shawn[2] investigated the optimal antibiotic regimen and duration of treatment. Operative findings are a better predictor of resource utilization in pediatric appendicitis, according to a 2015 study by Farach et al.[5] This finding aligns with our protocol, which incorporated more precautions so as not to neglect early post-appendectomy abscess formation. Prior to 2012, Nadler et al.[9] treated perforated appendicitis with a triple antibiotic regimen consisting of ceftriaxone, gentamicin, and metronidazole (triple antibiotics course). However, this regimen demands a complicated dosing schedule and blood tests to monitor nephrotoxic gentamicin levels. Recent research indicates that monotherapy with piperacillin/tazobactam for intra-abdominal infections is as effective as traditional triple therapy.[9] However, Individual doses of piperacillin/tazobactam are costly, and patients still require three to four doses per day. In our institution we spare this regimen for the resistant organisms or when it comes to the culture and sensitivity studies for the peritoneal fluid aspirated during the appendectomy.

During our study, although there was no significant statistical difference between the 2 groups there was an important clinical difference which reflected on the patient outcome.

In the first group, 5 cases had post operative abscess formation, 4 of them after complicated appendicitis cases (2 suppurative & 2 perforated) and 1 after simple inflamed appendicitis, where one which was discharged and re-admitted again.

In the second group, 4 cases had post operative abscess formation, only 1 after suppurative appendicitis and 3 cases after simple inflamed appendicitis. All of them were picked up before discharge from the hospital.

In the second group, none of them got re-admitted due to surgical complications; 2 patients were re-admitted in this group, 1 due to pneumonia with pleural effusions and the other with non-specific abdominal pain managed conservatively in general pediatrics after clearance from pediatric surgery. None of the postoperative collections in the second group was discharged home, all were picked up before being discharged and were treated early. Although The percentage of patients with perforated appendix in the second group (12%) is greater than those in the first group (5%), incidence of complications, re-admission and antibiotic cost is near in both groups which gave advantage to the second group.

CONCLUSION

We recommend the application of our management protocol as it has a clinical significance; less postoperative complications guiding the antibiotic duration and we can pick up of post operative collections before sending the patients to their homes. However, we recommend future prospective larger studies or randomized trials with the use of more sensitive inflammatory markers (like procalcitonin) to enhance the study's impact.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of the Medical Research Centre HMC Ethics Committee (Date: 10.08.2021, Decision No: MRC-01-21-446).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Acknowledgment

We appreciate the significant effort and help done by Dr. Prim Chandra, for doing the sample size and statistical analysis for our study as well as Mr. Eyad Abdelhamid for the professional English-editing done as required by the journal editors.

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