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Original article

Acute Appendicitis in Children; Is Surgery the Only Treatment Modality?

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Abstract

Background: Historically, appendectomy has been the treatment of choice for children with acute appendicitis. Nevertheless, there is growing interest in the effectiveness and security of non-invasive methods. **This study aimed to** comparing a non-operative therapy approach to appendectomy in children with simple acute appendicitis in terms of efficacy, safety, and cost-effectiveness. **Methods:** This prospective randomized controlled clinical trial was undertaken at Benha University Hospital from December 2022 to December 2023. The study comprised children between the ages of 4 and 16 who had uncomplicated acute appendicitis pediatric Appendicitis Score (PAS 4 to 6). Appendectomy and non-operative (antibiotic therapy) patient groups were established. Extensive examinations were conducted, encompassing clinical, laboratory, and radiographic studies. **Results**: 120 patients out of a total of 133 were studied (60 in each group). Significant variations were noted in PAS, laboratory tests, days of hospitalization, and problems prior to release across the groups. **Conclusion:** Significant disparities in outcomes between non-operative and appendectomy treatments in pediatric patients with uncomplicated acute appendicitis are suggested by the study. Non-operative therapy has exhibited potential advantages in some instances, including decreased hospitalization and equivalent safety results.

Keywords: Acute Appendicitis; Non-operative Treatment; Appendectomy; Pediatric Appendicitis Score; Antibiotic Therapy.

Introduction

Inflammation of the appendix occurs suddenly and is known as appendicitis. In addition to being a leading cause of stomach discomfort, especially in youngsters, it is also the most common surgical emergency. In patients who have never had an appendectomy before but are experiencing severe stomach discomfort, it should be considered (1).

Among the most prevalent intra-abdominal crises is acute appendicitis, which affects 89 out of 100,000 people every year and puts 7-8 percent of the population at risk of having the condition at some point in their lives (2).

The gold standard for treating acute appendicitis is appendectomy (3). On the other hand, there is growing concern in medical journals about the conservative approach to treating this prevalent ailment: Within the several years, a number of meta-analyses and randomized controlled trials have been carried out (4).

The antibiotic therapy's efficacy, safety, therapeutic appropriateness, and cost-effectiveness in comparison to surgical treatment of acute appendicitis are the primary concerns tackled by this research. Even though appendectomy is still the preferred therapy according to international standards, antibiotic management is still an option for simple cases of acute appendicitis (5).

An invasive treatment like an appendectomy might throw a child's regular schedule into a loop. 5 Complication rates for this curative treatment range from 5% to 10%, with 1% to 7% of patients experiencing major problems (6).

Reducing the need for appendectomy and associated costs, non-operative therapy (NOT) combines a wait-and-see strategy with medical treatment, limiting appendectomy to cases with severe appendicitis. NOT leads to regression lymphoid follicles which subsequently decrease inflammation and obstruction. The morbidity caused by acute appendicitis in children can be reduced with medical therapy, since it is feasible to avoid surgery and associated consequences (7).

The overall cost was lower in cases of NOT, and it is considered a cost-effective method with little hospital burden, even if some children required readmission owing to recurrent appendicitis (8).

The grey area about the exact line of treatment of query appendicitis in children and lack of approved guidelines has motivated the authors to conduct this study

Patients and methods

Study design:

The current study was a randomized clinical trial that was included children presenting to the emergency room at Benha University Hospital between

December 2022 and December 2023 with uncomplicated acute appendicitis.

Each patient was asked to sign a document indicating their fully informed permission. An explanation of the study's goal and a secret code number were given to each patient, after receiving approval from Benha University's Research Ethics Committee, the Faculty of Medicine (MS 50-10-2022).

Inclusion criteria were :This study included both boys and girls who were 4 to 16 years old, diagnosed with moderate probability acute appendicitis, and had a paediatric appendicitis score (PAS) less than 7 **(9).**

The exclusion criteria for this study included the following: admission with unstable vital signs such as hypotension and tachycardia despite resuscitation; clinical or radiological indications of perforated appendicitis; presentation with an appendix mass; previous non-operative treatment for appendicitis or appendix mass; known antibiotic allergies that preclude the allocation of non-operative treatment; or initiation of antibiotic therapy at the referring institution, which is defined as the administration of two or more doses.

Randomization:

It was done using specific software (Random Allocation Software 1.0, 2011). This block randomization was done by an independent investigator

Methods:

Complete preoperative assessment for all included patient was done include detailed medical history. A comprehensive clinical examination was undertaken, encompassing a systemic evaluation as well as a general assessment (including pallor or jaundice symptoms, vital signs including pulse, blood pressure, capillary filling time, and respiration rate, and temperature) (covering cardiovascular, respiratory, gastrointestinal, CNS, and musculoskeletal systems). The routine laboratory examinations comprised a random blood sugar evaluation, complete blood count, kidney function testing, and liver function tests. Radiological assessments consisted of abdominal-pelvic ultrasound, with the possibility of an abdominal CT scan if considered essential.

The participants were allocated into two distinct groups: the non-operative group, which received targeted antibiotic regimens initially intravenously and subsequently orally as soon as their clinical condition improved; and the appendectomy group, which underwent open appendectomy and concurrently received three doses of antibiotics in addition to standard post-operative care. Patients were administered a parenteral second-generation cephalosporin antibiotic while supinely positioned during surgery. The procedure was conducted under general anaesthesia, and a urinary catheter was introduced to facilitate the management of intraoperative and postoperative fluids.

Surgical technique:

All included patients underwent appendectomy other conventional surgical method or laparoscopic technique was applied

Patient care following surgery consists of prophylactic antibiotics, pain treatment, early ambulation, a progressive diet, and exercise levels raised in accordance with tolerance.

One week following the procedure, an outpatient clinic conducts postoperative follow-up to accomplish stitch removal and provide reassurance. Due to the impracticability of blinding for non-operative therapy, participants, parents, and staff are informed about the intervention. The same discharge criteria apply to both cohorts: maintenance of stable vital signs, absence of fever for at least 24 hours, tolerance to oral intake, effective pain management, and adequate mobility. At the time of discharge, participants are provided with information on symptoms that raise concerns or "red flags" and the recommended courses of action.

Forty-eight hours owing to symptoms worsening, or appendicitis recurrence within six months are used to ascertain non-operative therapy failure.

Follow up: Improvement or development of complications will be noted.

Participants will be asked to complete a diary card for the first 14 days following hospital discharge about: medication taken (antibiotics and analgesia), whether they are able to return to normal activity or full activity that day and if their parent(s) have to take time off work because of their appendicitis.

A clinic follow-up visit will be at 6 weeks with further trial follow-up at 3 and 6 months following discharge, in the outpatient clinic.

Failure of non-operative treatment will be defined if any one of the following is seen: abscess formation or complex peri-appendiceal fluid collection seen on ultrasonography, the need for surgery (due to worsening of symptoms evaluated by history, physical examination and repeat USG) within 48 hours, or recurrence of appendicitis within 6 months.

Outcomes:

Primary: effective treatment of children with query appendicitis without unneeded surgeries

Secondary: decrease overall cost and burden on the health care system

Statistical analysis

Sample size

The sample size required to achieve a power of $1 - \beta = 0.80$ (80%) for the Spearman's correlation at level $\alpha = 0.05$

(5%), under these assumptions amounts to 193 (G*Power, version 3.1)

An SPSS v26 statistical analysis was performed (IBM Inc., Armonk, NY, USA). The quantitative data were expressed as the mean and standard deviation (SD). To compare the two groups, unpaired Student's t-tests and ANOVA (F) tests were utilized. In instances where applicable, qualitative variables were evaluated using the Chi-square test or Fisher's exact test in conjunction with frequency and percentage (percent) presentations. A two-tailed P value less than 0.05 was deemed to indicate statistical significance.

Results

From December 2022 to December 2023, a prospective randomized clinical trial was carried out in the emergency department of Benha University Hospital. The study included a total of 120 subjects, who were divided into two groups: the Appendectomy group (60 children undergoing appendectomy) and the non-operative group (60 children receiving non-operative treatment). In the beginning, a total of 150 patients were enrolled; however, 17 were excluded for failing to meet the inclusion criteria or declining to participate, leaving 133 individuals. Following this, thirteen patients were lost to follow-up, leaving for analysis 120 people who were evenly allocated between the two groups. **Figure 1**

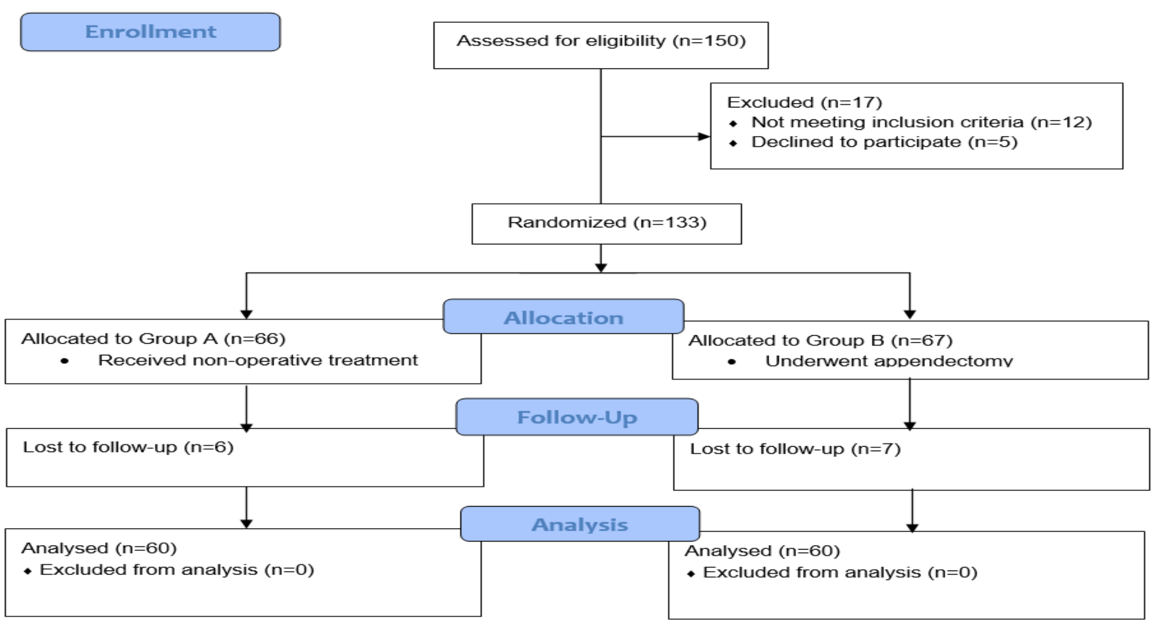

Figure 1: CONSORT flowchart

Overall, there were no substantial demographic differences observed between the two groups based on age or sex distribution. In terms of PAS, a substantial and statistically significant difference existed between the two groups under study. A statistically significant distinction was observed between the two groups under study with respect to laboratory studies. Regarding clinical manifestation, there was no statistically significant difference between the two groups examined. In terms of days of hospitalization, there was a substantial and statistically significant difference between the two groups under study. **Table 1**

A statistically significant distinction was seen between the two groups under investigation with respect to problems before to discharge. **Table 2**

Table 1: Comparison between studied cases according to demographic data

	Non-operative group (n = 60)		Appendectomy group (n = 60)		Test of sig.	p
Age (years)						
Range.	4 – 16		4 – 16		U=	0.899
Median (IQR)	8 (6 – 11)		9 (5 – 11.25)		1776.0	
	No.	%	No.	%		
≤6	23	38.3	23	38.3	χ^2=	1.0030
>6	37	61.7	37	61.7	0.0	
Sex	No.	%	No.	%		
Female	22	36.7	20	33.3	χ^2=	0.702
Male	38	63.3	40	66.7	0.147	
PAS						
Range.	5 – 9		7 – 10		U= 712.5	<0.001*
Median (IQR)	8 (6 – 8)		9 (8 – 10)			
TLC ($x10^3$)						
Range.	8.3 – 19.9		10.7 – 21.7		t=	0.001*
Mean ± SD.	13.73 ± 3.58		16.09 ± 3.8		3.503	
N%						
Range.	54.8 – 97.2		70 – 94		t=	0.004*
Mean ± SD.	75.44 ± 11.8		80.83 ± 7.6		2.973	
CRP (mg/L)						
Range.	5.5 – 66		5.4 – 143		U=	0.005*
Median (IQR)	28.5 (9.4 – 51)		38.5 (20 – 89)		1264.0	
Days of hospitalization						
Range.	3 – 7		3 – 12		728.0	<0.001*
Median (IQR)	5 (4 – 6)		8 (5 – 9)			

Data are presented as frequency (%) unless otherwise mentioned, SD: **Standard deviation,** IQR: **Interquartile range.**

Table 2: Comparison between studied cases according to complications

	Non-operative group (n = 60)		Appendectomy group (n = 60)		χ^2	p
Before discharge	No.	%	No.	%		
Abdominal Abscess	0	0.0	2	3.3	8.571	0.014*
SSI	0	0.0	6	10.0		
6 weeks						
Abdominal Abscess	1	1.7	3	5.0	1.034	0.309
3 months						
Abdominal Abscess	2	3.3	0	0.0	3.009	0.222
Functional paralytic ileus	0	0.0	1	1.7		
6 months						
Abdominal fluids	3	5.0	1	1.7	2.078	0.354

Data are presented as frequency (%).

Discussion

The present study observed a highly statistically significant difference in PAS between the two groups in this investigation. When it came to laboratory tests, the two groups were significantly different.

The validity of PAS scores as an indicator of appendicitis in children has been shown by several research. PAS ratings were recently verified by the assessment of ultrasonography results and histopathological reports. A further investigation confirmed that a PAS value of seven or higher was highly suggestive of appendicitis, with a zero percent chance of negative appendectomy observed. A local study found that the diagnostic accuracy of an Alvarado score of six or above in predicting acute appendicitis in children is 82.9% **(9)**.

Additionally, it was reported that an ultrasound examination identified appendicitis in 88.3% of the children. Although the correlation between paediatric appendicitis score and PAS was not statistically significant, ultrasound detected appendicitis in all children with a PAS of seven or higher; therefore, the paediatric appendicitis score is a valuable diagnostic tool, particularly in settings with limited resources (10).

An author who did a separate study found that children with a PAS of 3 maintained the same PAS even six hours later. Appendicitis was diagnosis-able in just one of ten children with PAS 3 who had surgery and had a biopsy performed. Thirty percent of the thirty children (49 percent) with a PAS between four and six had a repeat score of three or less; the remaining ten were admitted for surgery with a repeat PAS of seven or higher. Everyone’s biopsy revealed appendicitis. The histology of twenty children with an initial PAS of seven or more revealed appendicitis in seventy percent of those who had surgery. Therefore, a PAS value of seven or higher is highly suggestive of appendicitis, a condition that necessitates surgical intervention (11).

Regarding clinical presentation, the current investigation indicated no statistically significant difference between the two groups examined (Onset symptoms). A substantial statistically significant disparity was seen in the number of days of hospitalization between the two groups under investigation.

Another study found that conservative treatment failed in a similar proportion of patients depending on how long their symptoms lasted: just one patient out of nineteen (p = 0.18) failed if they came in within 12 hours, eight out of fifty-seven failed between 12 and 24 hours, and six out of fourteen failed after 24 hours (8).

This contradicts the results of a research that found that the average duration of stay on the first visit was 1.5 days (SD=1.0) for the NOM group and 1.3 days (p =0.61) for the OM group. The average duration of stay for each patient was 1.8 days (NOM) compared to 1.7 days (OM) (p = 0.97), considering any later readmissions. Compared to the OM (Operative Management) group, which had 2 repeat trips to the emergency room, the NOM group had 4 (0.3 per patient) (p = 0.51).(12).

Concerning complications, the current investigation indicated no statistically significant difference between the two groups.

In contrast, the study found that histology confirmed appendicitis in all ten patients within six months of follow-up, but no appendicolith. The patients all suffered from recurrent appendicitis. Complete victory was recorded in Group B. (p value 0.0001). The incidence of perforated or gangrenous appendix was 7.8%, or seven individuals. During the 6-month follow-up, one patient (1.1%) had adhesion blockage. It is not recommended for some youngsters since keeping the appendix helps boost immunity (13).

Additionally, it was shown that two out of twelve patients (16.7 percent) in the OM group acquired surgical site infections (SSIs), one of which was superficial and the other deep. The patient's pain management and antibiotic treatment necessitated two two-day readmissions because to a deep SSI. The problem was treated with antibiotics after imaging revealed a tiny intra-abdominal abscess that could not be percutaneously drained. Antibiotics were administered as an outpatient treatment to the patient who had a superficial SSI and was discovered to have an infected 5 mm port site in the left lower quadrant. The OM group has a greater risk of complications. Possible causes include the study's limited sample size, the absence of a standard procedure for perioperative antibiotic treatment, and the low severity of occurrences deemed as complications (14).

The good news is that individuals with simple appendicitis who initially had non-operative treatment did not have any complications. The fact that just fifteen (15/248, or 6%) of the individuals diagnosed with simple appendicitis were less than five years old might be a contributing factor. Thus, there is still a lack of clarity on the non-operative treatment of simple appendicitis in children younger than 5 years old (15).

Appendicoliths are frequently temporary and are linked to a low risk of appendicitis, according to recent reports. Regarding the complex appendicitis (16) demonstrated that, in the event of non-operative treatment for juvenile ruptured appendicitis, the existence of an appendicolith predicts the occurrence of recurrent appendicitis. In cases with simple appendicitis, in the current study found that appendicoliths, which were visible during the first non-operative treatment, occasionally go away during the follow-up (17). A novel diagnostic criterion for acute appendicitis may include intraluminal appendiceal fluid, according to reports. There was a 90% sensitivity and specificity rate for the diagnosis of acute appendicitis when the maximal depth of intraluminal appendiceal fluid was >2.6 mm, and 86.6% of appendicitis patients had this finding (18).

On the other hand, compared to individuals who had their appendix removed early on, those whose condition was first treated non-operatively and then had an interval appendectomy had a far greater incidence of complications. An evaluation of hospital charges and expenses revealed that early appendectomy resulted in substantially reduced expenditures (19). The second randomized controlled trial (RCT) compared the outcomes of 40 children whose perforated appendicitis had progressed to abscess formation: immediate appendectomy vs initial non-operative treatment followed by interval appendectomy at 10 weeks (20). Unlike the previous research that found no significant difference in total costs, recurrent abscess rate, or duration of hospitalization between the two groups. Patients who were handled with early surgery had a longer operative time and a longer time to resume their diet compared to patients who were first managed non-operatively with interval appendectomy. Other than that, there were no differences between the two groups. Patients with perforated appendicitis can safely undergo initial non-operative therapy, which has a success rate of 66–95 percent. Initial non-operative treatment may be beneficial for patients who have a fully developed abscess or mass (19).

With a risk of complications similar to appendectomy, the initial success rate of antibiotic therapy reached 90.5%. During the 1-year follow-up, 45 out of 168 patients (26.8% of the total) underwent interval appendectomy due to treatment failure (10 patients), histopathologically confirmed recurrence (27 patients), or parental demand (8 patients), indicating a higher risk of failure compared with urgent appendectomy (21).

Conclusion

Non-operative care, achievable via targeted antibiotic regimens, has potential as a viable substitute, as it achieves similar levels of safety and shortens the length of hospitalization. Nevertheless, although non-operative therapy may seem attractive in certain circumstances, appendectomy continues to be the only viable alternative, guaranteeing prompt remission while eliminating the possibility of recurrence.

References

1. Cameron DB, Anandalwar SP, Graham DA, Melvin P, Serres SK, Dunlap JL, et al. Development and Implications of an Evidence-based and Public Health-relevant Definition of Complicated Appendicitis in Children. Ann Surg. 2020;271:962-8.
2. Moris D, Paulson EK, Pappas TN. Diagnosis and Management of Acute Appendicitis in Adults: A Review. Jama. 2021;326:2299-311.
3. Snyder MJ, Guthrie M, Cagle S. Acute Appendicitis: Efficient Diagnosis and Management. Am Fam Physician. 2018;98:25-33.
4. Sallinen V, Akl EA, You JJ, Agarwal A, Shoucair S, Vandvik PO, et al. Meta-analysis of antibiotics versus appendicectomy for non-perforated acute appendicitis. Br J Surg. 2016;103:656-67.
5. Podda M, Gerardi C, Cillara N, Fearnhead N, Gomes CA, Birindelli A, et al. Antibiotic Treatment and Appendectomy for Uncomplicated Acute Appendicitis in Adults and Children: A Systematic Review and Meta-analysis. Ann Surg. 2019;270:1028-40.
6. Scott A, Lee SL, DeUgarte DA, Shew SB, Dunn JCY, Shekherdimian S. Nonoperative Management of Appendicitis. Clin Pediatr (Phila). 2018;57:200-4.
7. Sajjad MN, Naumeri F, Hina S. Non-operative treatment versus appendectomy for acute uncomplicated appendicitis: A randomized controlled trial. Pak J Med Sci. 2021;37:1276-81.
8. Minneci PC, Mahida JB, Lodwick DL, Sulkowski JP, Nacion KM, Cooper JN, et al. Effectiveness of Patient Choice in Nonoperative vs Surgical Management of Pediatric Uncomplicated Acute Appendicitis. JAMA Surg. 2016;151:408-15.
9. Parveen KZ, Avabratha KS, Shetty K. Pediatric appendicitis score in the diagnosis of childhood appendicitis: a validation study. Int J Contemp Pediatr. 2017;4:2196.
10. Iqbal T, Shahid MU, Shad IA, Bhatti SK, Gilani SA, Siddique Z. Diagnostic accuracy of gray scale ultrasonography versus color doppler in suspected cases of acute appendicitis: Acute appendicitis, gray scale ultrasonography, color doppler. Inter J Front Sci. 2021;5.
11. Jaremko JL, Crockett A, Rucker D, Magnus KG. Incidence and significance of inconclusive results in ultrasound for appendicitis in children and teenagers. Can Assoc Radiol J. 2011;62:197-202.
12. Varadhan KK, Neal KR, Lobo DN. Safety and efficacy of antibiotics compared with appendicectomy for treatment of uncomplicated acute appendicitis: meta-analysis of randomised controlled trials. Bmj. 2012;344.
13. Patkova B, Svenningsson A, Almström M, Eaton S, Wester T, Svensson JF. Nonoperative Treatment Versus Appendectomy for Acute Nonperforated Appendicitis in Children: Five-year Follow Up of a Randomized Controlled Pilot Trial. Ann Surg. 2020;271:1030-5.
14. Vons C, Barry C, Maitre S, Pautrat K, Leconte M, Costaglioli B, et al. Amoxicillin plus clavulanic acid versus appendicectomy for treatment of acute uncomplicated appendicitis: an open-label, non-inferiority, randomised controlled trial. Lancet. 2011;377:1573-9.
15. Bansal S, Banever GT, Karrer FM, Partrick DA. Appendicitis in children less than 5 years old: influence of age on presentation and

outcome. Am J Surg. 2012;204:1031-5; discussion 5.

16. Rollins MD, Andolsek W, Scaife ER, Meyers RL, Duke TH, Lilyquist M, et al. Prophylactic appendectomy: unnecessary in children with incidental appendicoliths detected by computed tomographic scan. J Pediatr Surg. 2010;45:2377-80.
17. Eun S, Ho IG, Bae GE, Kim H, Koo CM, Kim MK, et al. Neutrophil-to-lymphocyte ratio for the diagnosis of pediatric acute appendicitis: a systematic review and meta-analysis. Eur Rev Med Pharmacol Sci. 2021;25:7097-107.
18. Moteki T, Horikoshi H. New CT criterion for acute appendicitis: maximum depth of intraluminal appendiceal fluid. AJR Am J Roentgenol. 2007;188:1313-9.
19. Blakely ML, Williams R, Dassinger MS, Eubanks JW, 3rd, Fischer P, Huang EY, et al. Early vs interval appendectomy for children with perforated appendicitis. Arch Surg. 2011;146:660-5.
20. St Peter SD, Snyder CL. Operative management of appendicitis. Semin Pediatr Surg. 2016;25:208-11.
21. Hartwich J, Luks FI, Watson-Smith D, Kurkchubasche AG, Muratore CS, Wills HE, et al. Nonoperative treatment of acute appendicitis in children: A feasibility study. J Pediatr Surg. 2016;51:111-6.

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