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Research Article

Outcomes of Non-Operative Management versus Laparoscopic Appendectomy in Uncomplicated Acute Appendicitis in Adults

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Abstract

Background: Non-operative management (NOM) with antibiotics has emerged as an alternative to laparoscopic appendectomy for uncomplicated acute appendicitis (AA). This study compared outcomes of NOM versus laparoscopic appendectomy in adults.

Methods: In a prospective randomized controlled clinical trial, 100 adults with uncomplicated AA (Alvarado score >8) were allocated to NOM (Group A, n=50) or laparoscopic appendectomy (Group B, n=50). Demographics, clinical, laboratory, and radiological data were recorded. Primary outcomes were treatment success, recurrence, and complications; secondary outcomes included hospital stay, cost, and return to daily activities.

Results: NOM success was 84%, with 16% requiring appendectomy; 10% of initial responders experienced recurrence within 6–12 months. Histopathology in NOM failures revealed appendicoliths, acute inflammation, or lymphoid hyperplasia. Laparoscopic appendectomy had minor complications: paralytic ileus (4%), intra-operative bleeding (2%), and port-site hernia (2%). Group B showed shorter hospital stay (1.66 ± 0.69 *vs.* 4.12 ± 0.75 days, p<0.001), faster return to activity (5.82 ± 1.51 *vs.* 10.1 ± 1.92 days, p<0.001), but higher cost (12931.6 ± 152.89 *vs.* 7654.98 ± 141.96 EGP, p<0.001). Predictors of NOM failure included peri-appendicular free fluid, elevated leukocyte count, CRP, and diabetes mellites.

Conclusions: NOM is effective and cost-saving in highly selected uncomplicated AA cases but carries a risk of failure or recurrence. Laparoscopic appendectomy offers faster recovery and low complications. Careful patient selection and shared decision-making are essential.

Keywords: Acute appendicitis; Non-operative management; Laparoscopic appendectomy; Antibiotic therapy; Uncomplicated appendicitis

Introduction

Acute appendicitis (AA) is a frequently occurring cause of acute abdominal pain on a global scale, with an estimated lifetime risk of 7%–8%.Young and middle-aged individuals are frequently affected by AA; however, no age is immune. A male preponderance has been observed, with a male-to-female ratio of 1.4:1 [1].

Obstruction of the appendiceal lumen by fecal residue or lymphoid tissue proliferation is the primary cause of AA. This obstruction results in a high pressure within the lumen and damage to the mucosa [2].

In addition to the migration of periumbilical pain to the right lower quadrant of the abdomen, typical symptoms include fever, rebound tenderness, nausea, or vomiting. A rise in C-reactive protein and a shift in leucocyte count are frequently observed in laboratory tests. CT scan, transabdominal ultrasound, or MRI of the abdomen are frequently employed to confirm the diagnosis [3].

Since the early 20th century, appendectomy has been the preferred treatment for AA. Surgical management enables definitive treatment and significantly decreases the mortality and morbidity associated with the disease. [4]. Nevertheless, appendectomies are accompanied by inherent risks and complications, including anaesthetic risks and risks associated with surgery, such as haemorrhage, pain, prolonged ileus, negative appendectomy, pelvic collections, and surgical site infections. Trauma and emotional stress, as well as increased costs, are also associated with surgical treatment [5]. In comparison to the conventional open approach, laparoscopic appendectomy is now the preferred method due to its reduced risk of complications, shorter hospital stay, and early return to routine daily activities [1,2].

The non-operative management (NOM) of uncomplicated AA with antibiotics has been developed as a safe and viable alternative to surgery. This approach may be related to a faster recovery, a reduction in postoperative pain, and the avoidance of surgical scars [6]. It has the potential to reduce the burden on operating rooms and reduce overall costs, which could be beneficial to health care systems.

In the adult population, the recent CODA (Comparison of Outcomes of Antibiotic Drugs and Appendectomy) trial found that NOM of appendicitis was not inferior to appendectomy as a treatment for appendicitis [7].

When employing NOM for simple, uncomplicated appendicitis with a shorter duration of symptoms and the absence of faecolith, it has been demonstrated to have higher success rates [8].

The aim of the current study was to compare the outcomes of both, NOM (NOM) and laparoscopic appendectomy in cases of uncomplicated AA

Patients and Methods:

This prospective randomized controlled clinical trial was conducted on 100 patients diagnosed with uncomplicated AA with an Alvarado score greater than 8 in the Gastrointestinal and Laparoscopic Surgery Unit, General Surgery Department, Faculty of Medicine, Tanta University, during the period from November 2023 to October 2025.

The study protocol was approved by the Ethical Committee of the Faculty of Medicine, Tanta University. Written informed consent was obtained from all participants prior to enrolment.

Grouping and randomization:

The patients were randomly assigned to two equal groups using computer-generated randomization tables: Group A: NOM group, and group B: Surgical group undergoing laparoscopic appendectomy.

Patients were excluded if they had complicated AA (appendicular mass, perforation, abscess formation, or diffuse peritonitis), appendicular faecolith detected by ultrasonography or computed tomography, suspected appendiceal tumour on imaging, pregnancy or lactation, allergy to the antibiotics used in the protocol, previous non-operative treatment of appendicitis, severe systemic illness (ASA score ≥ III), or refusal to participate in the study.

Clinical evaluation:

History included duration of symptoms, abdominal pain characteristics, nausea, vomiting, anorexia, bowel habit changes, menstrual history in females, drug allergies, and associated comorbidities.

Physical examination included assessment of vital signs and abdominal examination focusing on right iliac fossa tenderness and guarding and other specific clinical signs as rebound tenderness (Blumberg's sign), Rovsing sign, etc.

Laboratory investigations:

Laboratory assessment included total and differential leukocytic count, C-reactive protein, urine analysis, pregnancy testing for women of childbearing age, and routine pre-anaesthetic investigations.

Radiological investigations:

Abdominal ultrasonography was performed for all patients to assess appendiceal diameter, fecolith presence, peri-appendicular fluid collection, and complications. Computed tomography was performed selectively in patients with unclear diagnosis, suspected complications, or patients older than 40 years to exclude neoplasms.

Intervention protocol

Group A: Non-operative management

Patients were admitted and received intravenous levofloxacin (500 mg once daily) for 72 hours or intravenous clindamycin (600 mg once daily) in quinolone-allergic patients, combined with intravenous metronidazole (500 mg three times daily) and intravenous paracetamol for analgesia.

Clinical reassessment was performed every 12 hours with daily monitoring of inflammatory markers. Patients showing clinical improvement were discharged on oral antibiotics for an additional 7 days.

Discharge criteria included absence of fever for 24 hours, tolerance of regular diet, no or minimal abdominal pain without limitation of patient regular activities, CRP ≤ 6 mg/L, and leukocyte count ≤ 11,000/μL.

Failure of conservative treatment was defined as persistent symptoms or worsening clinical or laboratory findings after 48 hours, requiring laparoscopic appendectomy. Recurrence was defined as reappearance of appendicitis after initial resolution.

Group B: Laparoscopic appendectomy

Preoperative preparation:

Patients underwent standard fasting (for 8 hours with only clear fluids allowed till 2 hours before surgery), anaesthetic evaluation, and optimization of comorbidities and preoperative antibiotic within one hour from the procedure. Informed consent included explanation of operative steps and possible conversion to open surgery.

Operative technique:

Under general anaesthesia, patients were placed in the supine Trendelenburg position with slight left tilt. Pneumoperitoneum was established using a Veress needle through a supraumbilical incision. Three ports were inserted: a 10-mm supraumbilical camera port and two 5-mm working ports (in the right lumber and left iliac fossa regions).

The appendix was identified following caecal retraction. The mesoappendix was divided using energy devices (bipolar diathermy or other vessel sealing devices), and the appendiceal base was secured with extracorporeal ligatures before division. The specimen was retrieved through the 10-mm port, followed by irrigation when required and closure of port sites.

Postoperative care:

Patients started oral fluids after 2 hours and progressed gradually to regular diet within 24 hours. Clinical monitoring was performed to detect postoperative complications.

The primary endpoints in both groups were development of complications and recurrence rate. Secondary endpoints included hospital stay duration, treatment cost, and time to return to normal daily activities.

Statistical analysis

Statistical analysis was done by SPSS v28 (IBM©, Armonk, NY, USA). The Shapiro-Wilks test and histograms were utilized to assess the normality of the distribution of data. Quantitative parametric data were presented as mean and standard deviation (S-D) and were analyzed by unpaired student t-test. Quantitative non-parametric data were presented as the median and interquartile range (IQR) and were analyzed by the Mann-Whitney test. Qualitative variables were presented as frequency and percentage (%) and analyzed using the Chi-square test or Fisher's exact test when appropriate. A two-tailed P value < 0.05 was considered statistically significant. The univariate logistic regression was utilized to estimate the relationship between a dependent variable and another independent variable.

Results

In this study, eligibility criteria were evaluated for 145 patients with acute appendicitis (AA). Forty-five patients were excluded from the study due to the following reasons: 11 patients declined to participate, 12 patients had complicated AA, 9 patients had appendicular faecolith diagnosed by ultrasound, 4 patients were pregnant, 5 patients had previously received non-operative treatment for AA, and 4 patients had severe systemic illness. The remaining 100 eligible patients were randomly assigned to two equal groups, with 50 patients in each group. All allocated patients were followed up and included in the statistical analysis, as shown in Figure 1.

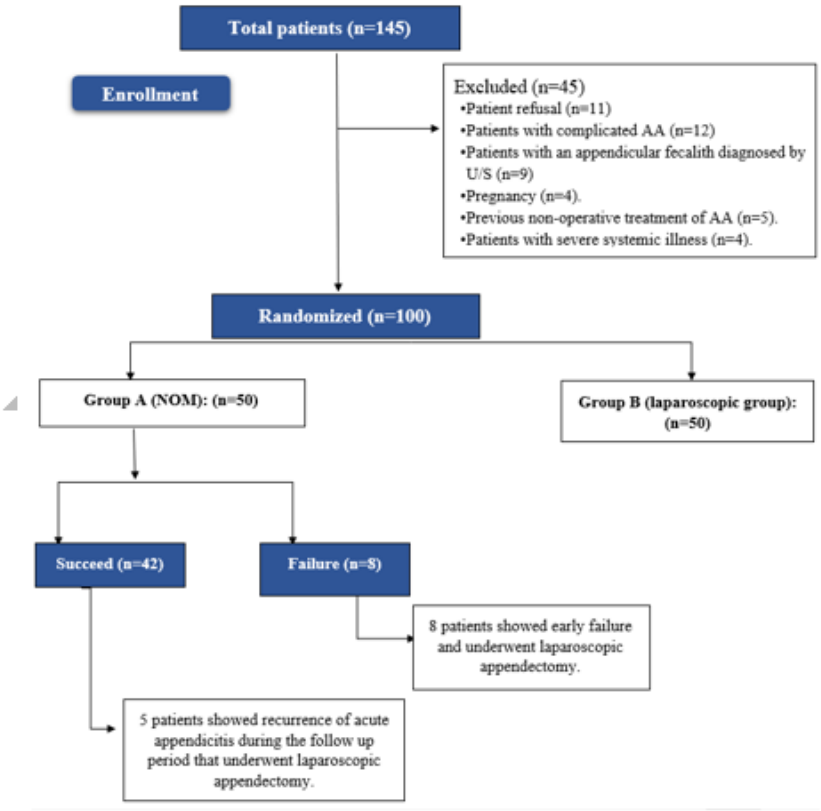

Figure 1: Consort flowchart of the studied patients.

Table 1 illustrates that there were no statistically significant differences between the two groups in terms of sex distribution, age, comorbidities, BMI, and ASA score. This suggests that the demographics of both groups were comparable at baseline, thereby reducing the possibility of confounding effects associated with patient characteristics.

Table 1: Comparison of demographic data between studied groups.

Variable	Group A (NOM) n=50	Group B (Laparoscopic) n=50	P value
Age (years)	31.38 ± 10.51	34.54 ± 11.61	0.157
Sex			
Male	19 (38%)	18 (36%)	0.605
Female	31 (62%)	32 (64%)	
BMI (kg/m²)	30.03 ± 5.95	30.79 ± 5.42	0.508
ASA score			
ASA I	32 (64%)	23 (46%)	0.070
ASA II	18 (36%)	27 (54%)	
Comorbidities			
Yes	18 (36%)	27 (54%)	0.070
No	32 (64%)	23 (46%)	
HTN	9 (18%)	20 (40%)	0.056
DM	11 (22%)	13 (26%)	0.639
Asthma	4 (8%)	7 (14%)	0.524

Data are presented as mean ± SD or frequency (%). NOM: Non-operative management, BMI: body mass index, ASA: American Society of Anesthesiologists score, DM: Diabetes mellitus, HTN: Hypertension.

The majority of clinical, laboratory, and radiological parameters were comparable between the two groups ($p > 0.05$). In contrast, Group B demonstrated a significantly higher incidence of peri-appendicular free fluid, CRP levels, total leukocyte count, and VAS pain scores ($p < 0.05$), which indicates a more severe inflammatory state at the time of presentation Table 2.

Table 2: Clinical, radiological, laboratory, and outcome data between studied groups.

Variable	Group A (NOM) n=50	Group B (Laparoscopic) n=50	P value
Duration of symptoms (hrs)	42.64 ± 17.26	40.44 ± 17.68	0.530
Admission >24 h	22 (44%)	30 (60%)	0.109
VAS score	5.72 ± 1.39	6.64 ± 1.14	<0.001*
Pulse (beats/min)	84.5 ± 8.19	83.5 ± 8.17	0.535
Tachycardia (pulse rate ≥ 100 bpm)	10 (20%)	15 (30%)	—
Temperature (°C)	37.78 ± 0.38	37.79 ± 0.36	0.872
Fever (temperature ≥ 37.5°C)	8 (16%)	15 (30%)	—
Appendix diameter (mm)	9.04 ± 1.01	9.66 ± 2.61	0.120
Omental reaction	30 (60%)	34 (68%)	0.404
Mesenteric LN	6 (12%)	7 (14%)	0.776
Free fluid	12 (24%)	25 (50%)	0.007*
TLC ($\times 10^9$/L)	13.52 ± 2.55	14.63 ± 2.24	0.023*
Leukocytosis (WBC > $11*10^9$/L)	36 (72%)	25 (50%)	—
Neutrophils (%)	84.06 ± 4.67	84.24 ± 4.76	0.849
CRP (mg/dL)	44.9 ± 24.71	56.72 ± 28.34	0.029*
Positive Elevated CRP (>6 mg/dL)	41 (82%)	36 (72%)	—
Alvarado score	9.2 ± 0.83	9.42 ± 0.50	0.112

Table 3 indicates that Group A experienced a significantly longer hospital stay and a delayed return to normal daily activities in comparison to Group B ($p < 0.001$). Conversely, Group A showed a significantly lower overall treatment cost ($p < 0.001$). These results underscore a trade-off between the cost savings associated with non-operative management and the expedited recovery that laparoscopic management offers. The mean operative time in the laparoscopic group was 53.7 ± 17.69 minutes.

Table 3: Outcome data between studied groups.

Variable	Group A (NOM) n=50	Group B (Laparoscopic) n=50	P value
Hospital stay (days)	4.12 ± 0.75	1.66 ± 0.69	<0.001*
Cost (EGP)	7654.98 ± 141.96	12931.6 ± 152.89	<0.001*
Return to activity (days)	10.1 ± 1.92	5.82 ± 1.51	<0.001*

In the Group A (NOM) patients, 84% of patients achieved complete symptom resolution, while 16% required surgical intervention as a result of treatment failure. Among initially successful cases, 10% developed recurrence within 6–12 months. Histopathology revealed appendicolith obstruction, acute inflammation, lymphoid hyperplasia, and occasional parasitic infection.

In Group B (laparoscopic), histopathology confirmed acute suppurative appendicitis in 80% of cases, while 20% showed lymphoid hyperplasia or missed appendicoliths. Regarding intra-operative adverse events, only one patient had intra-operative bleeding (2%) from accidental injured short appendicular artery that was controlled by monopolar diathermy. The procedure was safe, with only a few postoperative complications. Paralytic ileus (4%) was treated conservatively through the use of a nasogastric tube and the correction of electrolyte imbalances. There was also a port-site hernia at the umbilical port site that necessitated mesh hernioplasty subsequent to the procedure (2%).

Despite the fact that non-operative management achieved a high initial success rate (84%), 16% of patients required surgical intervention as a result of treatment failure. In addition, 10% of the cases that were initially successful experienced recurrence, suggesting that although NOM is effective in a significant number of patients, there is a risk of failure and recurrence **Table 4.**

Table 4: Success, Failure, and Recurrence between groups.

Outcome / Complication	Group A (NOM) n=50	Group B (Laparoscopic) n=50
Treatment success	42 (84%)	—
Treatment failure	8 (16%)	—
Recurrence after initial success	5 (10%)	—

Table 5 illustrates the univariate logistic regression analysis, which indicates that the failure of NOM was solely predicted by the presence of peri-appendicular free fluid, elevated total leukocyte count, elevated CRP, and high VAS at admission.

Table 5: Univariate logistic regression analysis for prediction of the failure of NOM.

	Odds ratio	95 % CI	P value
Age (years)	1.5341	0.3984 to 5.9077	**0.533**
Sex	1.5341	0.3984 to 5.9077	0.534
BMI (Kg/m^2)	1.0020	0.9001 to 1.1154	0.971
Comorbidities	0.4400	0.1035 to 1.8712	0.266
ASA	2.7576	0.7527 to 10.1030	0.125
Duration of symptoms (hrs.)	1.0108	0.9752 to 1.0476	0.558
Pulse (beats/min)	1.0103	0.9345 to 1.0923	0.796
Temperature measurement ($^{\circ}c$)	2.9461	0.4992 to 17.3861	0.224
Appendix diameter (mm)	1.0516	0.5561 to 1.9887	0.877
Omental reaction	1.7143	0.4464 to 6.5828	0.432
Mesenteric LN	0.8578	0.7307 to 1.0070	0.061
Peri-appendicular free fluid	1.0772	1.0056 to 1.1538	**0.034***
Operative time (min)	0.9972	0.9616 to 1.0342	0.881
Total leukocyte count ($*10^9/L$)	1.2994	1.0227 to 1.6509	**0.032***
Neutrophil count (%)	1.0011	0.8732 to 1.1476	0.988
CRP (mg/dL)	1.0144	0.9877 to 1.0418	**0.021***
Alvarado score	0.9048	0.2549 to 3.2113	0.877
VAS	1.5671	1.0101 to 2.4314	**0.045***

NOM: non-operative management, BMI: body mass index, American Society of Anaesthesiologists Physical Status Classification System HTN: Hypertension, DM: Diabetes mellitus, LN: lymph node, CRP: C-reactive protein, VAS: Visual analogue scale, *: statistically significant as P value <0.05.

Discussion

AA is the most prevalent abdominal and surgical emergency, with an annual incidence of 1.1 cases per 1000 individuals. Young and middle-aged individuals are frequently affected by AA; however, no age is impervious [2].

The demographic and clinical characteristics of both groups were well-matched in this study. The mean age, gender distribution, comorbidities, and ASA classification were comparable between the groups, which is consistent with the findings of previous studies by Anwar MF, et al. [9].

The mean total leukocyte count (TLC), C-reactive protein (CRP) levels, and peri-appendicular free fluid were significantly lower in patients managed with NOM than in the laparoscopic group in the current study. In accordance with our discoveries, Wakasa Y, et al. [10], reported that In comparison to the NOM group, the laparoscopic group exhibited a significantly higher initial CRP level and WBC count.

In comparison to group A, group B experienced a significantly shorter hospital stay, as indicated by our findings. In accordance with our discoveries, Ahmed MW, et al. [11]. The treatment cost was significantly lower in group A compared to group B, this finding is consistent with Gil LA, et al. [12].

Furthermore, Kiril Nikolov, et al. [13], stated that although the initial cost of laparoscopic appendectomy (LA) may be slightly higher than NOM for AA, LA is frequently regarded as a cost-effective strategy in the long term due to its shorter hospital stay and lower complication rates.

The duration of time required to resume normal daily activities was shorter in group B than in group A in our study. This discovery is in accordance with the findings of Salminen P, et al. [14].

In the present study, 42 patients (84%) in group A responded successfully to NOM at the time of initial admission. The remaining 8 patients (16%) failed to respond and subsequently underwent laparoscopic appendectomy. 5 patients (10%) underwent laparoscopic appendectomy during a second admission after experiencing recurrent attacks of appendicitis 6–12 months after initial treatment during follow-up. This rate of recurrence is similar to that reported by Hansson J, et al. [15], who observed a 12% recurrence in patients treated non-operatively.

Intraoperative bleeding (2%), paralytic ileus (4%), and port-site hernia (2%) comprised the 8% overall complication rate of laparoscopic appendectomy in our investigation. These results are in accordance with Ciscar A, et al. [16].

The high success rate observed in the current study can be attributed to the strict selection criteria that excluded patients with complicated AA, those with an appendicolith identified on preoperative imaging, and those with suspicion of a tumor on preoperative imaging.

A number of factors have been identified in our study as predictors of recurrence following NOM of AA, such as: Inadequate antibiotic coverage or poor adherence to therapy, which may allow persistent infection, increased peri-appendicular free fluid, elevated CRP and TLC levels in primary admission, which took a longer time to improve during treatment, and diabetic patients were more likely to show a poor response to antibiotics and higher recurrence rates, including many who ultimately required appendectomy. These results indicate that diabetes may be a significant risk

Conclusion

NOM with antibiotics exhibits a success rate in selected patients with uncomplicated AA and provides the benefit of a lower cost. Nevertheless, our results also suggest that the laparoscopic approach offers a number of advantages over the NOM, such as a shorter hospital stay, an earlier return to normal daily activities, and generally superior clinical outcomes. In carefully selected cases, NOM can be considered a safe alternative to surgery, provided that patients are adequately informed about the risk of treatment failure, the potential for recurrence, and the potential need for a subsequent appendectomy. It is crucial that the surgeon and the patient collaborate to determine whether or not to pursue NOM.

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