Original Article

Nonperforated acute appendicitis, should it be managed as a surgical emergency to be operated at the same night of presentation or it can be delayed to the next day elective list?: A retrospective study

Ahmed S.M. Omar, Hatem S. Saber and Mohamed G. Qassem

Department of General Surgery, Ain Shams University, Cairo, Egypt.

ABSTRACT

Background: The safety of delaying appendectomy has been widely debated in the surgical literature. Regardless patient-related causes for delay like patients coming from rural areas, sometimes surgical management is delayed due to many causes like diagnostic uncertainty, lack of patient fasting, night presentation, patients with comorbidities who need special preparation, failed trial for management with antibiotics, and atypical picture of presenting symptoms. We conducted this study to evaluate the safety of 1 night delay before surgery for nonperforated acute appendicitis.

Patients and Methods: Retrospective evaluation of 1942 patients older than 12 years with nonperforated acute appendicitis in the period between December 2019 and November 2023. We excluded patients with diffuse peritonitis, pregnant women, negative appendectomy, incidental, interval appendectomy, combined surgery (with urologists, obstetricians, and gynecologists), operation after consultations from other departments, and patients with severe comorbidities requiring intensive care.

Results: The study included 1127 (58.03%) males and 815 (41.97%) females with a mean age of 23.87±8.86 years. The classic migrating pain from periumbilical region to the right iliac fossa was present in 1107 (57%) patients. Patients were presented after 1–2.5 days following symptoms onset. The hospital interval which means time from ER admission till surgery 'system time' ranged 9–24 h. Superficial surgical site infection occurred in 136 (7%) patients while intra-abdominal fluid collection occurred in 13 (0.67%) patients with no mortality.

Conclusion: Our study confirms and contributes additional evidence supporting that nonperforated acute appendicitis in selected patients is safe for surgical delay up to 24 h under the administration of intravenous antibiotics. It is not a true surgical emergency that should be operated at the same night of presentation. The duration of patients' symptoms before hospital presentation is the most important factor for final patients' outcome rather than the system time of delay.

Key Words: Acute appendicitis, hospital delay, hospital interval, nonperforated, surgical emergency.

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Corresponding Author: Ahmed S. M. Omar, MD, Department of General Surgery, Ain Shams University, Cairo, Egypt. **Tel.:** 01003324336, **E-mail:** ahmed_samy@med.asu.edu.eg

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INTRODUCTION

Acute inflammation of the appendix is one of the most prevalent general surgical emergencies worldwide[1,2]. It is reported that 7.0–10.0% of emergency department visits are due to acute appendicitis[3]. The reported lifetime risk of incidence of acute appendicitis is 7–8% worldwide which means that approximately one in 13 persons will suffer acute appendicitis[4]. Although acute appendicitis is relatively rare at the extremes of age, it may occur at any age. The risk of developing acutely inflamed appendix is more in the second and third decades of life with 8.6% male predominance relative to 6.7% female incidence with a 1.4 : 1 male/female ratio[5–7].

There are several theories for the pathophysiology of acute appendicitis. Many reports document that appendiceal luminal obstruction usually is the initiating cause of acute appendicitis[8]. Other studies denote that luminal obstruction is not an initiating factor for acute appendicitis in most patients with phlegmonous appendicitis[9,10]. Whether the appendix is obstructed or not, finally bacterial proliferation with the invasion of the appendiceal wall by intraluminal bacteria is the result[11,12]. Many factors can contribute to luminal obstruction such as fecolith, lymphoid hyperplasia, parasites particularly ascaris, tumors whether primary or metastatic, plant seeds, and barium following diagnostic contrast studies[13].

Appendiceal luminal obstruction causes a rise in the luminal pressure which can reach up to 65 mmHg and more[9]. This high pressure exceeds the venous pressure leading to impairment of lymphatic and venous drainage resulting in mucosal ischemia secondary to thrombosis of the venous drainage of the appendix with continuous arteriolar supply which occurs when the luminal pressure

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increases more than 85 mmHg[9,14]. Mucosal ischemia leads to ulceration with invasion of the appendiceal wall by intraluminal bacteria most commonly E-coli and Enterococci[8,9,14].

The progression of appendiceal inflammation is variable and judged by many factors and sometimes it may be delayed or even aborted by the patient's defense mechanism helped by antibiotics[15]. These important factors include extremes of age, associated diseases like obesity and diabetes, immunosuppression, location of the appendix, presence of fecolith, and omentum. Pregnant females, children, and the elderly are more likely to develop complicated appendicitis[16]. With the progression of the disease if the omentum is well developed, it surrounds the inflamed appendix forming an appendicular mass thus localizing the infection and preventing it from spreading more to the adjacent bowel and peritoneum. If the appendix is perforated and gets surrounded by omentum then an appendicular abscess develops.

Noncomplicated and complicated appendicitis are distinct diseases with different morbidity of about 6.9% in simple appendicitis relative to 20.1% in complicated appendicitis[17]. Clinically it is very important to differentiate between simple and complicated appendicitis because steps of management will differ between both of them. Despite that importance, no universally agreed definition is present for classification of both entities. Many trials were made for differentiate between simple and complicated appendicitis (Table 1). There is a scoring system that has been validated by the American Association for the Surgery of Trauma (AAST) to evaluate disease severity by using clinical, radiographic, operative, and pathological criteria[18].

Table 1: Proposed definition for complicated appendicitis by many trials

	Proposed definition for complicated appendicitis
World Society of Emergency Surgery[7,17]	Perforated, nonperforated gangrenous, with fecolith and/or presence of pus, or purulent peritonitis, or abscess.
JAMA review[6]	Perforated with abscess or phlegmon formation.
European Association of Emergency Surgery[19]	Gangrene +/– perforated, intraperitoneal abscess, and fluid collection.
The CODA collaborative[20,21]	Septic shock, diffuse peritonitis, recurrent appendicitis, evidence of severe phlegmon on imaging, intraperitoneal abscess, free air or more than minimal free fluid, or evidence suggestive of neoplasm

JAMA: Journal of the American Medical Association
CODA trial: Comparison of Outcomes of Antibiotic Drugs and Appendectomy

There is no debate that early diagnosis and proper surgical management of acute appendicitis is the goal to achieve the best results. Appendectomy was considered the mainstay for treatment of acute appendicitis since it was first reported by McBurney in 1889 until recently there were many efforts for conservative management of acute appendicitis with antibiotics. In a systematic review by the American College of Surgeons, they reported that in simple appendicitis ‘antibiotic-first‘ approach was likely safe in most of cases, but they and other authors of meta-analysis have maintained that appendectomy is still the mainstay of management for simple appendicitis[22,23].

Recently there was great controversy regarding the appropriate time of surgery for appendicitis. It was reported that the perforation risk is time-dependent and delayed time to surgery increases patient morbidity[24]. Also it was reported by many authors that simple noncomplicated inflammation of the appendix may resolve spontaneously without need for surgery with good results[25], or can be managed conservatively with antibiotics[26,27], or surgically managed on elective basis without increasing morbidity[28,29].

Patient morbidity, mortality, risk of perforation, and poor surgical results are directly related to the stage of appendicular and perpendicular inflammation at the time of the operation. Increasing rates of appendiceal perforation and wound infections have been associated with delayed surgery according to some authors[30,31]. In contrast, others had related appendiceal perforation to prehospital delay which means that perforation had already occurred before the patient arrival to the hospital, whereas no relation was found with in-hospital delay[30,32]. We retrospectively conducted this study to evaluate non-perforated acute appendicitis, whether to be operated on the same night or it can be delayed to the next day's elective list.

PATIENTS AND METHODS:

This retrospective study was conducted at Ain Shams University hospitals in Egypt and Saudi Hospital in Hajja city, Yemen. After approval of the ethical committee, 1942 patients with nonperforated acute appendicitis in the period between December 2019 and November 2023 were retrospectively evaluated.

Inclusion criteria

All patients with nonperforated appendicitis older than 12 years.

Exclusion criteria

(a) Patients with perforated appendicitis presented with general peritonitis, septic shock (those patients underwent urgent surgical management at the same night of presentation).

(b) Patients managed nonoperatively; who were treated conservatively with antibiotics, or those were subjected to percutaneous drainage in case of appendicular abscess.

(c) Patients with: negative appendectomy, incidental, and interval appendectomy.

(d) Pregnant women and those who were under 13 years of age.

(e) Combined surgery (with urologists, obstetricians, and gynecologists), and operation after consultation from other departments.

(f) Patients with severe comorbidities requiring postoperative intensive care.

History, physical examination, and laboratory investigations were carried out for all patients including preoperative white blood cell count, neutrophil count, the neutrophil to white blood cell ratio, C-reactive protein levels, hemoglobin, biochemistry as blood sugar and liver and kidney functions in selected patients, pelviabdominal ultrasound, and pregnancy test for females in the reproductive age. Abdominal computed tomography (CT) scan with contrast was spared for selected cases with nonconclusive ultrasound, when diagnosis was not clear, or when perforation was suspected.

Antibiotics such as third-generation cephalosporin or ciprofloxacin plus metronidazole were started without delay just after surgical diagnosis of acute appendicitis and were continued until patient discharge. Laparoscopic appendectomy was the preferred initial approach while open surgery was done if there is a contraindication for laparoscopy or in patients with previous abdominal surgeries where adhesions were suspected.

The primary decision for surgical intervention and timing of appendectomy was made by the attending surgeon, with consideration for both clinical urgency and logistical feasibility. The main outcome of interest was perforation with peritonitis to operate these patients at the same night of presentation. Surgical interventions at night had been restricted to patients who are critically ill with an expected serious morbidity and mortality if not operated urgently after rapid resuscitation. Patients with nonperforated appendicitis were defined as having a noncritical health condition and were scheduled to have surgery on the second day morning elective list.

The main predictors of interest were patient interval (duration between onset of symptoms as nausea, vomiting, and abdominal pain till hospital presentation), and hospital interval or system time (time between ER arrival till surgery). Cases with appendiceal perforation were also analyzed to determine whether the perforation happened before or after hospital presentation. The following factors were documented from the medical records then assessed:

Age.

Sex.

Patient interval (Duration of symptoms till hospital presentation).

Hospital interval (time of ER arrival till surgery).

Diameter of the appendix as reported by ultrasound and CT.

Presence of fecolith.

Operative time.

Length of hospital stay.

Operative and postoperative complications.

All appendectomy samples were histologically evaluated. Based on the histological evaluation, specimens were classified into five grades by disease severity score: grade 1, inflamed; grade 2, with gangrene; grade 3, perforation with localized collection; grade 4, perforation with abscess formation and grade 5, perforation with general peritonitis[33]. Medical records were examined to assess ER re-presentation in the 30-day postoperative period for any complication like ileus, collection or surgical site infection. Complication in our study was defined as any deviation from the normal postoperative course even after hospital discharge within 1 month following appendectomy.

RESULTS:

Statistical analysis

The data were entered into an Excel database where continuous data were presented as mean ± SD. Categorical data were presented as frequencies and percentages.

Patient demographics

In this study, 1942 patients with nonperforated acute appendicitis in the period between December 2019 and November 2023 were retrospectively evaluated. The age ranged 13–76 years with a mean age of 23.87±8.86 years (Table 2). The study included 1127 (58.03%) males and 815 (41.97%) females (Table 3).

Presenting symptoms

Nausea and loss of appetite were present in 1807 (93.04%) patients and vomiting was present in 1530 (78.78%) patients. Pain in the right lower quadrant was present in 1690 (87.02%) patients, while 21 (1.08%) patients had flank pain at the right lumbar area in subhepatic appendicitis. Pain at the suprapubic area was present in 185 (9.52%) patients in cases of pelvic appendicitis, while central periumbilical pain was present in 39 (2%) patients. The classic migrating pain from the periumbilical region to the right iliac fossa was present in 1107 (57%) patients. Fever was present in 330 (16.99%) patients (Table 3).

Atypical presentation

Three (0.15%) patients were atypically presented with abdominal distention only; they were diagnosed as having acute appendicitis after CT scan of the abdomen. Picture of gastroenteritis including diarrhea and vomiting was present in four (0.2%) patients. Epigastric pain was the only presenting symptom in five (0.25%) patients (Table 3), and Lt iliac fossa pain in two (0.1%) patients (intraoperatively found that the inflamed tip of appendix was present in a retroileal position crossing the midline in a transverse direction to left iliac fossa in a thin patient).

Duration of symptoms

Patients were presented after 1–2.5 days following symptoms onset with a mean duration of 1.55±0.41 days. Four hundred seventy-three (24.35%) patients were presented after 1 day, 901 (46.39%) patients were presented after 36 h, 458 (23.6%) patients were presented after two days, and 110 (5.66%) patients were presented after 60 h following symptoms onset (Table 3).

Diagnostic imaging

Abdominal ultrasonography was the primary diagnostic imaging modality in all patients. It was sometimes repeated in patients with non-conclusive initial ultrasound. CT scan of the abdomen was spared for 148 (7.62%) patients with atypical symptoms where diagnosis also was not clear by ultrasound. The diameter of the inflamed appendix ranged 5.5–15 mm with a mean diameter of 8.24±1.66 mm (Table 2). Fecolith was present in the lumen of the appendix in 188 (9.68%) patients, while ascaris worms accounted for appendiceal luminal obstruction in 38 (1.95%) patients.

The waiting time until surgery

Nearly two-thirds (66.01%) of patients were presented from evening till midnight, while the remaining third (33.99%) of patients were presented after midnight till early morning. The hospital interval which means the time from ER admission till surgery 'system time' ranged 9–24 h with a mean duration of 13.83±4.89 h.

Causes for system delay

Regardless patient-related causes for the delay to be presented to ER like the distance from the hospital especially in rural areas where patients seek medical advice first in primary care units, sometimes surgical management is delayed due to many causes like diagnostic uncertainty, lack of patient fasting, night presentation, patients with comorbidities who need special preparation, failed trial for management with antibiotics, atypical picture of presenting symptoms, and sometimes for unavailability of the operating room at the time of patient presentation.

Rate of perforation and relation to system delay

In this study, the diagnosis of acute appendicitis was made mainly by history and clinical examination plus abdominal ultrasound which was repeated for patients with unclear diagnosis or when the initial ultrasound denoted no definite signs of acute appendicitis. All patients who were not operated at night were examined again in the second day before surgery to evaluate new symptoms and signs. Only one (0.05%) patient examination denoted signs of pelvic peritonitis and was found to have perforated appendicitis during operation.

Operative time

Either due to expected adhesions resulting from previous abdominal surgeries or when there was a contraindication to laparoscopy like in patients with pulmonary or cardiac comorbidities, 33 (1.7%) patients were managed from the start by open appendectomy with operative time ranging 18–70 min with mean time of 36.75±16.27 min (Table 2). In the remainder 1909 (98.3%) patients, the operative time ranged 22–68 min with mean time of 34.69±8.41 min, we started with laparoscopic appendectomy where 118 (6.18%) patients were required to convert the procedure to open approach either because of difficult location of the appendix plus severe and dense adhesions, friable base of the appendix, and iatrogenic ascending colon injury in one patient with adherent retro colic phlegmonous appendicitis.

Length of hospital stay

The hospital stay ranged 2.5–5 days calculated from ER presentation till discharge from the hospital with a mean duration of 2.72±0.32 days (Table 2). Hospital stay was increased in some patients either due to vomiting following surgery which delayed initiation of oral intake due to prolonged postoperative ileus, or surgical site infection which required frequent dressing and control of infection before patient discharge from the hospital.

Postoperative complications

One (0.05%) patient suffered postoperative reactionary hemorrhage which was managed by returning the patient back to the operating room for control of bleeding from friable mesoappendix. Superficial surgical site infection occurred in 136 (7%) patients where the major number of them was in patients who were either operated by open approach from the start or those with conversion from laparoscopic to open approach (Table 3). This superficial wound infection was managed by the removal of some stitches with frequent dressings good wound wash with saline, and antibiotics according to the result of culture and sensitivity.

Postoperative intra-abdominal fluid collection occurred in 13 (0.67%) patients, they were managed by ultrasound-guided aspiration plus continuation of intravenous antibiotics till discharge from the hospital. Seven (0.36%) patients were readmitted within 1 month following surgery for abdominal distension and vomiting with diagnosis of paralytic ileus which responded to conservative management. Nine patients had postoperative chest infection which ranged from acute bronchitis to basal lobar pneumonia in one patient. No mortality or major complications was documented in our study. During the 4 years of the study period, adhesive intestinal obstruction was seen in 72 (3.7%) patients where three of them needed laparotomy for release of adhesions with smooth postoperative recovery.

Table 2: Patient age, diameter of appendix, hospital interval, operative time, and hospital stay

Characteristic	Mean	Range
Age (years)	23.87±8.86	13–76
Diameter of appendix (mm)	8.24±1.66	5.5–15
Hospital interval (h)	13.83±4.89	9–24
Operative time (min)		
Open appendectomy 33 (1.7%) patients	36.75±16.27	18–70
Laparoscopic appendectomy 1909 (98.3%) patients	34.69±8.41	22–68
Hospital stay (days)	2.72±0.32	2.5–5

Table 3: Patient sex, presenting symptoms, duration of symptoms, and postoperative complications

Item	Distribution	*N* (%)
Sex	Male	1127 (58.03)
	Female	815 (41.97)
Presenting symptoms	Anorexia and nausea	1807 (93.04)
	Vomiting	1530 (78.78)
	Periumbilical pain	39 (2)
	Shifting pain to RIF	1107 (57)
	Fever	330 (16.99)
	Abdominal distension	3 (0.15)
	Diarrhea and vomiting	4 (0.2)
	Epigastric pain	5 (0.25)
	Lt iliac fossa pain	2 (0.1)
Duration of symptoms	1 day	473 (24.35)
	1.5 days	901 (46.39)
	2 days	458 (23.6)
	2.5 days	110 (5.66)
Postoperative complications	Reactionary hemorrhage	1 (0.05)
	Superficial surgical site infection	136 (7)
	Intra-abdominal fluid collection	13 (0.67)
	Paralytic ileus	7 (0.36)
	Chest infection	9 (0.46)
	Adhesive intestinal obstruction	72 (3.7)

DISCUSSION

There is no debate that early diagnosis and proper surgical management of acute appendicitis is the goal to achieve the best results. Appendectomy was considered the mainstay for the treatment of acute appendicitis until recently there were many efforts for conservative management of acute appendicitis with antibiotics. The optimal timing for appendectomy and the safety of delaying surgical management of nonperforated acute appendicitis have been widely debated in the surgical literature and it is not only an old but also a controversial issue. An example for this controversy: it is safe to delay appendectomy for uncomplicated appendicitis up to 24 h according to the World Society of Emergency Surgery guidelines[7], while the European Association for Endoscopic Surgery reported increased perforation risk following surgical delay[34].

In this study, we found that it is safe for selected patients with nonperforated acute appendicitis for surgical delay up to 24 h under the administration of intravenous antibiotics. In our experience, nonperforated acute appendicitis in selected patients is not a true surgical emergency that should be operated at the same night of presentation and one night of hospital delay do not increase surgical complications. Appendectomy can be done with second day list on semi elective basis and no need to rush for surgery at night with exhausted surgeons and nurses to spare their effort for a true surgical emergency.

Studies on conservative management of nonperforated acute appendicitis with intravenous antibiotics sparing surgery only after failure of antibiotic management or when there is a recurrence of symptoms, found that the complication rate in patients with non-perforated acute appendicitis was not increased when the hospital interval was increased (when surgery was delayed). The perforation rates are 10.8 and 17.9% in patients with failed conservative management and patients with immediate surgical management, respectively, after randomization[35]. In contrast, it was noted that appendectomy done after 12 h following hospital presentation was associated with a higher risk of perforated appendicitis (29.7 vs. 22.7%)[31], moreover, the perforation rate is 28.8 and 33.3% if the surgical delay is 24 h and between 24 and 48 h, respectively[36]. In the analysis reported by Alore *et al*.[37] they found a complication rate of 8% for appendectomies done 2 days following hospital presentation relative to rates of 3.4 and 3.6% for surgeries delayed to 24 h and 48 h, respectively.

Regardless patient-related causes for delay to be presented to ER like the distance from the hospital especially in rural areas where patients seek medical advice first in primary care units, surgical management is delayed due to many causes like diagnostic uncertainty, lack of patient fasting, night presentation, patients with comorbidities who need special preparation, failed trial for management with antibiotics, atypical picture of presenting symptoms, and sometimes for unavailability of the operating room at the time of patient presentation. The relationship between system delay following ER (Emergency room) admission and surgical results has been investigated by several authors who concluded that delaying surgical management of nonperforated acute appendicitis was not associated with increased complications[28,31,38].

The most important factors for operative and postoperative complications are duration of symptoms and time of hospital presentation following symptoms onset[39,40], and many authors reported that the perforation rate was not increased due to a short system delay before appendectomy[28,29,39,41–45]. Ditillo *et al*. reported that advanced inflammation and more grades of pathology are related to prehospital delays, not to the hospital interval[40]. Busch *et al*. documented that system delay of more than 12 h was an independent factor for perforation risk[31], while others like Teixeira *et al*. documented that despite perforation risk was not increased when there was system delay, but the wound infection rate increases[30].

A major explanation for our findings about the safety of delaying surgery for uncomplicated appendicitis in selected patients is that some appendicular inflammation may be spontaneously resolved or with the aid of intravenous antibiotics when the decision goes for conservative management[26,27]. Also, antibiotic injection manages infectious and inflammatory factors even for advanced stages of perforated appendicitis, till elective appendectomy after resolution of inflammation like in cases with appendicular mass and abscess. This also is augmented by the theory that non-complicated and complicated appendicitis are distinct diseases with different pathophysiology with morbidity of about 6.9% in simple appendicitis relative to 20.1% in complicated appendicitis[17]. Mostly appendicitis perforates at earlier stages before hospital presentation. In this study, all patients were examined again in the second day before surgery to evaluate new symptoms and signs. Only one (0.05%) patient examination denoted signs of pelvic peritonitis and found to have perforated appendicitis during operation. In our opinion, the patient's signs were underestimated during the initial examination and he has perforated appendicitis from the start rather than related to system delay.

Patient morbidity and poor surgical results are directly related to the stage of appendicular and

periappendicular inflammation at the time of the operation. Our results match our hypothesis that non-perforated appendicitis is not a true surgical emergency and postoperative surgical results are related to the overall time interval from initial symptoms to appendectomy. Papziagas and colleagues[46] and a systematic review by van Dijk *et al*. reported that surgical complications were not increased if patients were operated on within 24 h[47]. Partelli, *et al*. also concluded in their report that surgical results are not affected when appendectomies for non-perforated appendicitis are postponed to the following day elective list[48]. It is suggested that there is a variation in the immune response to perforated and non-perforated appendicitis augmented by distinct inflammatory markers with high immune-triggered tissue destruction which causes appendiceal perforation in perforated appendicitis, and not the sequel or the following step secondary to hospital delay[49–51].

CONCLUSION

Our study confirms and contributes additional evidence supporting that nonperforated acute appendicitis in selected patients is safe for surgical delay up to 24 h under the administration of intravenous antibiotics. Nonperforated acute appendicitis is not a true surgical emergency that should be operated at the same night of presentation and the efforts of the attending surgeon should be spared for real surgical emergencies. The duration of patients' symptoms before hospital presentation is the most important factor for final patients' outcome rather than the system time of delay.

CONFLICT OF INTEREST

There are no conflicts of interest.

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