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Impact of Surgical Timing on Management of Acute Appendicitis: A Comparative Retrospective Study

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Abstract

Background: The optimal timing for surgical intervention in acute appendicitis remains a subject of ongoing debate. This study aimed to compare the clinical outcomes of early versus delayed appendectomy, and to assess the feasibility and safety of delayed surgical management.

Methods: A retrospective review was conducted on medical records of patients who underwent appendectomy for acute appendicitis between April 1, 2023 and April 30, 2024. Patients were divided into two groups based on the period between when the patient was admitted to the hospital and when the surgery started: Group A (≤ 8 hours) and Group B (> 8 hours). Primary outcomes included white blood cell (WBC) count on the first postoperative day, time to initiation of soft diet, complication rate, surgical site infection (SSI) rate, length of hospital stay, and readmission within two weeks.

Results: Out of 354 patients, 48 were excluded according to predefined criteria, leaving 306 patients for analysis. Group A included 164 patients (53.6%), and Group B included 142 patients (46.4%).

Baseline demographic and clinical characteristics showed no meaningful differences between Group A and Group B. Group B had lower mean WBC counts on postoperative day one compared to Group A (p 0.0052). There were no notable variations between the groups in terms of time to resume a soft diet, duration of hospitalization, incidence of complications, or readmission within two weeks. SSI occurred in 3 patients (1.8%) in Group A and 5 patients (3.5%) in Group B (p = 0.2260), showing no statistically significant difference.

Conclusions: Delayed appendectomy (> 8 hours) is a safe and feasible option for adult patients with acute appendicitis. Although delayed surgery did not demonstrate superior clinical outcomes compared to early appendectomy, the timing of intervention can be adapted based on hospital workflow and resource availability.

Keywords: Acute Appendicitis, Early Appendectomy, Delayed Appendectomy, Surgical Timing, Outcomes.

تأثير توقيت الجراحة على علاج التهاب الزائدة الدودية الحاد: دراسة مقارنة استعادية

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الخلفية:
يبقى التوقيت الأمثل للتدخل الجراحي في حالات التهاب الزائدة الدودية الحاد موضوعًا محل نقاش مستمر. هدفت هذه الدراسة إلى مقارنة النتائج السريرية بين استئصال الزائدة الدودية المبكر والمتأخر، وتقييم مدى جدوى وسلامة العمليات الجراحية المؤجلة.

الطرق:
تم إجراء مراجعة استعادية للسجلات الطبية للمرضى الذين خضعوا لاستئصال الزائدة الدودية نتيجة التهاب حاد في الفترة من 1 أبريل 2023 حتى

30 أبريل 2024، تم تقسيم المرضى إلى مجموعتين استنادًا إلى الفترة الزمنية من القبول في المستشفى حتى بدء العملية الجراحية: المجموعة (أ) ≤ 8 ساعات، والمجموعة (ب) > 8 ساعات، شملت النتائج الأولية عدد كريات الدم البيضاء في اليوم الأول بعد الجراحة، ووقت البدء في تناول الطعام اللين، ومعدل المضاعفات، ومعدل الإصابة بعدوى موقع الجراحة، وطول مدة الإقامة في المستشفى، وإعادة الدخول خلال أسبوعين

النتائج:

من أصل 354 مريضًا، تم استبعاد 48 مريضًا وفقًا لمعايير محددة مسبقًا، ليبقى 306 مرضى ضمن التحليل النهائي. شملت المجموعة (أ) 164 مريضًا (46.4%) والمجموعة (ب) 142 مريضًا (53.6%)، لم تُسجَّل فروق ذات دلالة إحصائية في الخصائص السكانية أو السمات السريرية قبل الجراحة بين المجموعتين. أظهرت المجموعة (ب) انخفاضًا في متوسط عدد كريات الدم البيضاء في اليوم الأول بعد الجراحة مقارنة بالمجموعة (أ) (القيمة الاحتمالية = 0.0052). لم تُلاحظ فروق معنوية في وقت البدء في تناول الطعام اللين، أو مدة الإقامة في المستشفى، أو معدل المضاعفات، أو معدل إعادة الدخول خلال أسبوعين. حدثت عدوى في مكان الجراحة لدى 3 مرضى (1.8%) في المجموعة (أ)، و5 مرضى (3.5%) في المجموعة (ب) (القيمة الاحتمالية = 0.2260)، مما يشير إلى عدم وجود فرق ذي دلالة إحصائية.

الاستنتاجات:

يُعد استئصال الزائدة الدودية المؤجل (> 8 ساعات) خيارًا آمنًا وقابلًا للتنفيذ لدى المرضى البالغين المصابين بالتهاب الزائدة الدودية الحاد. وعلى الرغم من أن الجراحة المؤجلة لم تُظهر تفوقًا في النتائج السريرية مقارنة بالجراحة المبكرة، إلا أن توقيت التدخل يمكن أن يُعدَّل حسب سير العمل في المستشفى وتوافر الموارد.

الكلمات المفتاحية:

. التهاب الزائدة الدودية الحاد، استئصال الزائدة المبكر، استئصال الزائدة المتأخر، توقيت الجراحة، النتائج السريرية.

Introduction

Acute appendicitis is widely recognized as the most common emergency requiring abdominal surgery. Traditionally, surgeons have favored prompt appendectomy immediately after diagnosis, considering it the most effective treatment approach to prevent complications.

based on the long-standing belief that any delay in surgical intervention may lead to increased postoperative morbidity or progression to complicated appendicitis, such as perforation or periappendiceal abscess formation [1] [2]. However, this traditional approach has been increasingly questioned in recent years. Several studies have proposed that acute appendicitis may be managed conservatively with antibiotics, or that delaying surgical intervention does not necessarily result in worse clinical outcomes [3][4][5][6][7]. Conversely, other investigations have reaffirmed the necessity of prompt surgical intervention, indicating that postponing appendectomy may lead to higher complication rates and longer hospital stays [8][9][10]. Given this ongoing debate, the timing of appendectomy continues to be a controversial topic. The objective of this study was to compare the clinical outcomes of early versus delayed appendectomy and to evaluate the safety and feasibility of delayed surgical management in adult patients with acute appendicitis.

Materials and Methods

Patients

This retrospective, observational study was conducted at Ibn Sina Hospital and a private surgical clinic, Sirte Libya.

Medical records of patients diagnosed with acute appendicitis who underwent appendectomy between April 1, 2023, and April 30, 2024, were reviewed.

Patients were excluded based on the following criteria:

1. Age younger than 14 or older than 60 years.
2. Patients who had additional surgical interventions performed simultaneously with the appendectomy (such as gallbladder or ovarian procedures).
3. Female patients who were pregnant, as well as individuals with major health conditions necessitating admission to intensive care units.
4. Cases involving incidental, interval, or negative appendectomies were also excluded from the study.

After applying the exclusion criteria, eligible patients were categorized into two groups according to the time interval from hospital arrival to surgical incision:

- Group A: patients who underwent appendectomy within less than 8 hours.
- Group B: patients whose surgery was performed after more than 8 hours.

Data Collection

Clinical data were retrospectively collected from archived patient records.

The following parameters were extracted and analyzed: patient demographics, duration from symptom onset to presentation, the collected data included the duration between hospital admission and diagnosis, the interval from diagnosis to surgical intervention, patients' initial vital signs, baseline laboratory parameters, the surgical approach used for appendectomy, the presence of any drainage procedures, and laboratory findings after surgery. Additional variables included time to initiation of soft diet, complications following surgery, duration of hospitalization, and readmission within two weeks following surgery.

Preoperative, intraoperative, and postoperative clinical data were compared between the two groups.

Outcome Measures
Outcome measures included white blood cell (WBC) count on the first postoperative day, time to initiation of soft diet, overall complication rate, surgical site infection (SSI), length of hospital stay, and readmission within two weeks following surgery.

Statistical Analysis
Statistical analysis was performed using Jamovi statistical software version 2.4.8 (The Jamovi Project, Sydney, Australia). Continuous variables were presented as means ± standard deviations (SD) and compared between the two groups using Student's t-test for normally distributed data or Wilcoxon rank sum test for non-normally distributed data. Categorical variables were expressed as numbers and percentages and compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant.

Results
During the study period, a total of **354** patients underwent appendectomy for acute appendicitis. Of these, **48** patients were excluded based on the predetermined exclusion criteria, leaving **306** patients eligible for inclusion in the study.

Table 1 summarizes the overall demographic and clinical characteristics of the included patients. The mean age was **37years**. 133 females (43.5%) and 173 males (56.5%) were present. Three hours on average passed between hospital admission and diagnosis, 6.8 hours between diagnosis and surgery, and 9.8 hours between arrival and appendectomy.
Based on the time interval from arrival at the hospital to surgical incision, patients were categorized into two groups: **Group A** (≤ 8 hours; *n* = 164, 53.6%) and **Group B** (> 8 hours; *n* = 142, 46.4%).

Table 1 . Clinical Features and Demographic Information

Variable	Value
Total cases	306
Age (years)	37 ± 13.3
Male: Female	173(56.5%): 133(43.5%)
Body mass index (kg/m²)	22.6± 3.1
Initial temperature of the body (°C)	37.5 ± 0.8
initial count of white blood cells (WBCs) (×10³/mm2.)	12.7 ± 2.4
Comorbidities	23 (7.5%)
Arrival time to diagnosis in hours	3.0 ± 2.0
Hours between diagnosis and surgery	6.8± 4.6
Hours between arrival and incision	9.8 ± 5.1
Appendectomy technique (LA: OA)	245(80.0%): 61(19.9%)
Operation at night (21:00–05:00)	41 (13.4%)
Complicated appendicitis	42 (13.7%)
Appendicoliths	102 (33.3%)
Combined drainage	16(5.2%)
WBC, postoperative first day (×10³/mm³)	10.3 ± 2.4
Soft diet time (day)	1.9 ± 1.0
Hospital stay following surgery (day)	4.0 ± 2.6
Complication	10 (3.2%)
Readmission within two weeks	2 (0.7%)

Table 2 summarizes the differences between the two groups' preoperative and demographic data. As anticipated by the study design, the time intervals showed statistically significant variations. However, the groups did not differ statistically significantly in terms of initial white blood cell (WBC) count, body temperature, body mass index (BMI), sex distribution, age, or comorbidities.

Table 2. Comparisons of Two Groups' Preoperative Features and Demographics

Variable	Group A (≤ 8 hours)	Group B (> 8 hours)	P value
quantity of cases	164 (53.6%)	142(46.4%)	—
Age (yrs)	32.6 ± 11.7	31.4± 11.2	0.2647
Sex ratio (Male: Female)	98:66	75:67	0.4195
Body mass index (kg/m²)	22.7 ± 3.2	22.1± 3.1	0.1041
Temperature of the body (°C)	37.5 ± 0.8	37.5 ± 0.7	0.8912
The initial count of white blood cells (×10³/mm³)	12.5 ± 2.3	13.1 ± 2.6	0.0389
Comorbidities	15 (9.1%)	8 (5.6%)	0.2669
Arrival time to diagnosis in hours	2.5 ± 1.2	3.7 ± 2.5	<0.0001
Hours between diagnosis and surgery	3.4 ± 1.6	10.2 ± 4.4	<0.0001
Hours between arrival and incision	5.9 ± 1.7	13.9 ± 4.1	<0.0001

The operational differences between the two groups are shown in **Table 3**. The rate of laparoscopic appendectomy, operating time, frequency of difficult appendicitis, presence of appendicoliths, and use of combined drainage did not differ significantly. However, a statistically significant difference was found in the proportion of operations performed at night (**Group A: 20.7% vs. Group B: 4.9%; p < 0.0001**) and in the use of combined drainage (**Group A: 9.1% vs. Group B: 2.8%; p = 0.0149**).

Table 3. Comparing Group A's (≤ 8 hours) and Group B's (> 8 hours) operational characteristics

Variable	Group A (≤ 8 hours)	Group B (> 8 hours)	P value
Laparoscopic appendectomy, n (%)	146 (89.0%)	99 (69.7%)	<0.0001
Operation at night (21:00–05:00), n (%)	34 (20.7%)	7 (4.9%)	<0.0001
Operating time (minutes)	47.3 ± 7.6	51.2 ± 8.7	0.0025
Complicated appendicitis, n (%)	25 (15.2%)	17 (12.0%)	0.4191
Appendicoliths, n (%)	68 (41.5%)	34 (24.0%)	0.0015
Combined drainage procedure, n (%)	15(9.1%)	4 (2.8%)	0.0149

Table 4 provides specific postoperative results. On the first postoperative day, Group B's mean WBC count was considerably lower than Group A's (p = 0.0052). There were no statistically significant differences between the two groups in terms of readmission within two weeks, overall complication rates, postoperative hospital stay, or time to resume soft diet. While Group B showed a marginally higher rate of surgical site infections (**Group A: 1.8% [n = 3]; Group B: 3.5% [n = 5]**), the variation was not statistically meaningful. (p = 0.2260).

Table 4. Comparison of Two Groups' Postoperative Results

Variable	Group A (≤ 8 hours)	Group B (> 8 hours)	P value
WBC, first day postoperative (×10³/mm³)	10.6 ± 2.6	9.7 ± 2.4	0.0052
Soft diet time (day)	2.1 ± 1.1	1.8 ± 0.7	0.0620
Hospital stay following surgery (day)	4.3 ± 2.7	4.2 ± 2.6	0.0854
Complication, case (%)	2 (1.2%)	8 (5.6%)	0.0489
Infection at the surgical site, case (%)	3 (1.8%)	5 (3.5%)	0.2260
Two-week readmission, case (%)	1 (0.6%)	1 (0.7%)	0.9281

Discussion

All patients in this study underwent abdominal ultrasonography for confirmation of acute appendicitis, and in selected cases, abdominal computed tomography (CT) was used to support the diagnosis and rule out other intra-abdominal pathologies.

Among emergency surgical interventions, appendectomy continues to be a frequently performed procedure by general surgeons due to its high incidence and urgent nature [11] [12]. Traditionally, it is performed shortly after diagnosis to prevent disease progression to perforation or periappendiceal abscess. However, improvements in antibiotic quality over the last decades have introduced alternative strategies such as interval appendectomy for cases of periappendiceal abscess, which have demonstrated favorable outcomes compared to immediate surgery [13] [14]. Furthermore, several studies have reported successful non-surgical antibiotic treatment for selected cases of uncomplicated appendicitis [6] [15] [16]. Nevertheless, appendicitis is still considered primarily a surgical disease.

The ideal timing for performing an appendectomy remains a topic of considerable debate among clinicians. While some studies support early appendectomy to reduce complications, others describe postoperative problems, such as surgical site infections [9] [10] [17] [18], and some report no discernible difference in outcomes between early and delayed appendectomy [8] [19] [20] [21]. Moreover, several studies have shown that prolonged working hours and sleep deprivation negatively affect clinical performance and decision-making, particularly among surgical trainees [22] [23].

In reality, the timing of surgery is often influenced by various logistical and institutional factors, such as limited operating room access, anesthesia availability, equipment shortages, and surgeon preference, as confirmed by surveys among pediatric surgeons [24]. In our institutions, although surgeons generally preferred early appendectomy, factors such as reduced number of surgical residents and increasing operative case load have naturally led to longer waiting times, especially during night shifts.

The preoperative clinical and demographic parameters of the early and delayed appendectomy groups did not differ significantly in our study. This implies that the existence of complications, fever, or WBC count did not affect the date of surgery.

Additionally, the presence of appendicoliths did not significantly differ between the groups, which contrasts with some studies that reported a correlation between appendicoliths and complicated appendicitis [25] [26].

Both groups' postoperative results, including length of hospital stay and time to soft diet, were similar. Crucially, the overall rate of complications and surgical site infections (SSI), including the development of intra-abdominal abscesses, did not differ statistically significantly. Postoperative intra-abdominal abscesses caused only one patient in group A and one in group B to be readmitted within two weeks. These results are in line with other research that suggested delayed appendectomy might be safe in certain situations [7] [19] [20].

Interestingly, the mean WBC count on the first postoperative day was significantly lower in the delayed group. This may be attributed to multiple doses of effective intravenous antibiotics administered preoperatively in this group. In our practice, patients diagnosed with uncomplicated appendicitis received first- or second-generation cephalosporins, while those with complicated appendicitis also received metronidazole [27]. Patients in the early group typically received a single preoperative antibiotic dose, whereas those in the delayed group received two or more doses prior to surgery.

This study has several limitations. Firstly, as a retrospective observational study, it is susceptible to selection bias and confounding factors. Secondly, due to operational limitations such as staff shortages and tight operating schedules, a prospective randomized design was not feasible. Lastly, our study does not define an exact safe delay interval. Further large-scale prospective randomized trials are needed to determine the optimal timing of appendectomy in patients with acute appendicitis.

Conclusion

Despite emerging interest in non-operative management for selected cases of acute appendicitis, appendectomy remains the definitive and standard treatment. The present study demonstrates that delayed laparoscopic appendectomy is a safe and viable approach in adult patients, with comparable postoperative outcomes to those undergoing early intervention. Although no clear advantage was observed in delaying surgery, it did not result in increased morbidity or prolonged recovery.

Based on the results, surgical timing can be adjusted to fit hospital capacities and staffing levels, provided that the patient's condition remains stable., without compromising patient safety or clinical outcomes. Further prospective studies are warranted to establish evidence-based guidelines for optimal surgical timing.

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