

# EARLY OPERATIVE MANAGEMENT OF COMPLICATED APPENDICITIS IS ASSOCIATED WITH IMPROVED SURGICAL OUTCOMES IN ADULTS: A SYSTEMATIC REVIEW

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## Abstract

**Introduction:** Appendectomy is one of the most common surgeries in the US, with over 300,000 performed annually. In addition, 20% of adults may have complex appendicitis with extensive peritonitis, perforation, abscess, or phlegmon. In severe appendicitis patients, there is no unanimity on whether to operate or when. Statistics contradict each other. Non-operative care and radiologically guided percutaneous drainage have become prominent treatments.

**The aim:** This article demonstrated an association between early surgical management of complicated appendicitis and enhanced surgical outcomes in adults.

**Methods:** By comparing itself to the standards set by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, this study was able to show that it met all of the requirements. So, the experts were able to make sure that the study was as up-to-date as it was possible to be. For this search approach, publications that came out between 2013 and 2023 were taken into account. Several different online reference sources, like Pubmed and SagePub, were used to do this. It was decided not to take into account review pieces, works that had already been published, or works that were only half done.

**Result:** In the PubMed database, the results of our search brought up 68 articles, whereas the results of our search on SagePub brought up 51 articles. The results of the search conducted for the last year of 2013 yielded a total 19 articles for PubMed and 13 articles for SagePub. In the end, we compiled a total of 11 papers, 7 of which came from PubMed and 4 of which came from SagePub. We included three study that met the criteria.

**Conclusion:** The benefits of immediate surgery for patients with complicated appendicitis include a reduction in hospitalization time, subsequent infections, and short-term mortality, according to research.

**Keyword:** Complicated appendicitis; Operative management; Outcomes

**INTRODUCTION**

Appendicitis, the most common abdominal surgery emergency, requiring prompt treatment to avoid serious consequences. Late appendicitis treatment increases morbidity and mortality.<sup>1</sup> Appendicitis is inflammation of vermiform appendix organ. One of the most common acute abdominal cases is acute appendicitis. Appendicitis is usually caused by blockage and infection. Hyperplasia of lymphoid tissue, fecaliths, foreign bodies, strictures, kingking, and adhesions can obstruct. If the proximal appendix is obstructed, mucus accumulates in the lumen, raising intraluminary pressure. Mild acute appendicitis occurs when lymph flow disrupted, causing edema and mucosa damage.<sup>2,3</sup>

Appendicitis is inflammation of the vermiform appendix organ. One of the most common acute abdominal cases is acute appendicitis.<sup>4</sup> Perforated appendicitis is distinct. Disease can cause perforation instead of therapeutic delay. This means that most of the appendix will be perforated when you arrive at the hospital, and quick surgery cannot prevent it.<sup>5</sup> Perforation occurs in 20-30% of acute appendicitis patients. Perpration can cause wound infection, abscesses, and peritonitis. Perforated appendicitis can cause a rare abdominal wall abscess that increases mortality.<sup>6</sup>

Appendix abscesses are pus-filled inflammations. Soft lump in right lower quadrant or pelvis. This lump starts as phlegmon and becomes a pus-filled cavity. When the omentum covers gangrenous appendicitis or microperforation. Peritonitis caused by abdominal organ lining infection. A thin, transparent membrane covers the abdominal organs and inner abdominal wall: the peritoneum. Peritonitis can be localized or widespread, acute or chronic, and infectious or aseptic. Emergency peritoneitis often involves bacteremia or sepsis.<sup>7</sup>

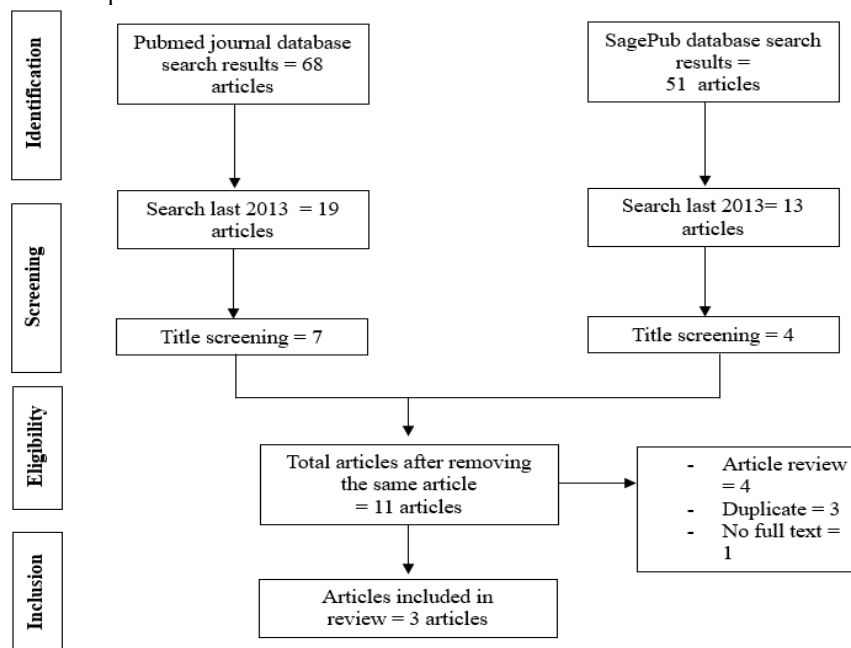
In the United States, appendectomy is one of the most common surgical procedures, with over 300,000 appendectomies performed each year. Furthermore, up to 20% of adults may present with complex appendicitis, which may include widespread peritonitis, perforation, abscess, or phlegmon.<sup>8</sup> In patients who have difficult appendicitis, there are contradicting statistics that guide the decision of whether or not to operate as well as the timing of the operation, and there is no clear consensus. In recent years, non-operative care and radiologically guided percutaneous drainage have gained popularity as treatment options.<sup>9,10</sup>

Several older studies, including two meta-analyses of complicated appendicitis, have shown that immediate operative management is associated with higher rates of complications. On the other hand, a small randomized trial in adults with an abscess demonstrated that immediate laparoscopic surgery was associated with fewer readmissions and CT scans, as well as fewer complications and re-interventions.<sup>9-11</sup> According to the findings of this study, early surgical care of complex appendicitis is associated with improved surgical outcomes in adults. This association was shown to be significant.

**METHODS**

The person in command of this study took steps to ensure strict adherence to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines. The purpose of this method is to ensure the accuracy of the investigation's findings. This study's primary objective was to demonstrate that early surgical management of complicated appendicitis is associated with better surgical outcomes in adults. The primary objective of this study is to demonstrate the significance of the aforementioned and book-discussed topics. To be eligible for inclusion in the study, researchers had to meet certain requirements.

One of these requirements was that the paper had to be written in English and concentrate on how early operative management of complicated appendicitis is associated with better surgical outcomes in adults. To be published, the paper must satisfy both of these requirements. Several of the publications being evaluated were published in 2013 and within the predetermined timeframe deemed pertinent to the objectives of this systematic review. Editorials, submissions without a Digital Object Identifier (DOI), previously published review articles, and submissions that duplicate previously published journal articles are prohibited in the academic context.



**Figure 1. Article search flowchart**

We used “early operative management”; “complicated appendicitis”; and “surgical outcomes” as keywords. The search for studies to be included in the systematic review was carried out from September, 13<sup>th</sup> 2023 using the PubMed and SagePub databases by inputting the words: (“early”[All Fields] AND (“operability”[All Fields] OR “operable”[All Fields] OR “operate”[All Fields] OR “operated”[All Fields] OR “operates”[All Fields] OR “operating”[All Fields] OR “operation s”[All Fields] OR “operational”[All Fields] OR “operative”[All Fields] OR “operatively”[All Fields] OR “operatives”[All Fields] OR “operator”[All Fields] OR “operator s”[All Fields] OR “operators”[All Fields] OR “surgery”[MeSH Subheading] OR “surgery”[All Fields] OR “operations”[All Fields] OR “surgical procedures, operative”[MeSH Terms] OR (“surgical”[All Fields] AND “procedures”[All Fields] AND “operative”[All Fields]) OR “operative surgical procedures”[All Fields] OR “operation”[All Fields]) AND (“manage”[All Fields] OR “managed”[All Fields] OR “management s”[All Fields] OR “managements”[All Fields] OR “manager”[All Fields] OR “manager s”[All Fields] OR “managers”[All Fields] OR “manages”[All Fields] OR “managing”[All Fields] OR “managment”[All Fields] OR “organization and administration”[MeSH Terms] OR (“organization”[All Fields] AND “administration”[All Fields]) OR “organization and administration”[All Fields] OR “management”[All Fields] OR “disease management”[MeSH Terms] OR (“disease”[All Fields] AND “management”[All Fields]) OR “disease management”[All Fields]) AND (“complicances”[All Fields] OR “complicate”[All Fields] OR “complicated”[All Fields] OR “complicates”[All Fields] OR “complicating”[All Fields] OR “complication”[All Fields] OR “complication s”[All Fields] OR “complications”[MeSH Subheading] OR “complications”[All Fields]) AND (“appendical”[All Fields] OR “appendicitis”[MeSH Terms] OR “appendicitis”[All Fields]) AND (“surgical procedures, operative”[MeSH Terms] OR (“surgical”[All Fields] AND “procedures”[All Fields] AND “operative”[All Fields]) OR “operative surgical procedures”[All Fields] OR “surgical”[All Fields] OR “surgically”[All Fields] OR “surgicals”[All Fields]) AND (“outcome”[All Fields] OR “outcomes”[All Fields])) AND (y\_10[Filter]) AND (clinicaltrial[Filter])) used in searching the literature.

The researchers checked each paper's abstract and title for inclusion. The essay authors then chose relevant research from the literature. An comprehensive review of several studies with a consistent pattern led to this outcome. All written pieces must be in English and unpublished before submission. The systematic review only included papers that met all inclusion criteria. This limits search results to those related to the user's query. Studies that don't match our standards are ignored. The research findings will be thoroughly analyzed. The investigation for this research turned up the following: names, authors, release dates, place, study activities, and parameters.

Before deciding which publications to look into more, each author did their own study on the research in the title and abstract of each publication. The next step is to look at all of the articles that meet the standards for the review and decide which ones to include. Then, based on what we find, we'll decide which stories to include in the review. This criterion is used to choose papers that need to be looked at more closely. To make it as easy as possible to choose works to be evaluated. This part talks about the previous studies that have been done and why they were included in the review.

**RESULT**

In the PubMed database, the results of our search brought up 68 articles, whereas the results of our search on SagePub brought up 51 articles. The results of the search conducted for the last year of 2013 yielded a total 19 articles for PubMed and 13 articles for SagePub. In the end, we compiled a total of 11 papers, 7 of which came from PubMed and 4 of which came from SagePub. We included three study that met the criteria.

**Table 1. The litelature include in this study**

Author	Origin	Method	Sample Size	Result
<b>Leite, 2022</b> <sup>12</sup>	United State of America	Cross sectional study	11,208 patients	The implementation of delayed operational treatment has been shown to potentially result in a decrease in the requirement for prolonged resection appendectomy, a shorter duration of the surgical procedure, and a tendency towards decreased death rates. Conversely, it could also be linked to an extended duration of hospitalization and immediate health complications.
<b>Kim, 2019</b> <sup>13</sup>	Republic of Korea	Cross sectional study		The utilization of elective interval surgery (EIS) may prove advantageous for a specific subset of adult patients diagnosed with complex appendicitis.
<b>Symer, 2018</b> <sup>14</sup>	United State of America	Cross sectional study	31,167 patients	In this study conducted at the population level, an investigation was undertaken to examine the occurrence of difficult appendicitis. The findings revealed a higher incidence of complications, an extended length of stay (LOS), and increased charges in patients who underwent delayed surgery.
<b>Helling, 2017</b> <sup>15</sup>	United State of America	Cross sectional study	611 adult patients were admitted with the diagnosis of appendicitis	The surgical management of patients who present with severe appendicitis is more favorable compared to non-operative treatment focused on antibiotics, as it leads to a reduction in length of hospital stay (LOS) and the requirement for readmissions.

Leite, et al (2022)<sup>12</sup> showed the rate of extended resection appendectomy was significantly reduced with delayed operational management (risk ratio [RR] = 2.15, 95% confidence interval [CI] = 1.59–2.81,  $p < 0.001$ ). There was no significant reduction in mortality linked with delayed operational management (RR = 2.17; 95% CI = 0.98–2.85,  $p = 0.05$ ). Delayed operational treatment also reduced overall operative time and postoperative abscess rate. No correlation was found between delayed intervention and medical morbidity (RR = 1.01; 95% CI = 0.91–1.11,  $p = 0.811$ ). However, delayed surgical treatment significantly increased total length of stay (coefficient = 1.10; 95% CI = 1.02 to 1.18,  $p < 0.001$ ).

Kim, et al (2019)<sup>13</sup> showed EIS group had lower rates of ileo-cecectomy or right hemicolectomy (1.5% vs. 6.9%,  $P = 0.031$ ), postoperative complications (6.9% vs. 13.7%,  $P = 0.067$ ), wound infection (1.5% vs. 8.4%,  $P = 0.010$ ), and shorter hospital stays (3.72 days vs. 5.82 days,  $P < 0.001$ ) compared to the ES group. Multivariate analysis showed that delayed surgery for more than 48 hours or urgent surgery owing to EIS failure and open conversion were independent risk factors for postoperative problems ( $P = 0.001$  and  $P = 0.025$ ). In subgroup analysis, high American Society of Anesthesiologists physical state categorization and distant abscess or widespread ascites in first CT enhanced EIS failure risk.

Symer, et al (2018)<sup>14</sup> showed individuals who underwent appendectomy at an early stage were more commonly of White ethnicity (69.8% vs. 64.2%,  $p < 0.01$ ) and had commercial insurance coverage (53.1% vs. 45.4%,  $p < 0.01$ ). Out of the total sample size of 3152 individuals who were scheduled for delayed surgery, 1610 individuals (51.1%) underwent surgery at a later time during their first hospital stay, 715 individuals (22.7%) were urgently readmitted and subsequently underwent appendectomy, and 827 individuals (26.2%) underwent elective appendectomy. The study found that patients who underwent delayed surgery experienced a higher incidence of problems (odds ratio [OR] = 1.34, 95% confidence interval [CI] = 1.23-1.45), readmissions (OR = 1.55, 95% CI = 1.42-1.70), increased hospital charges (OR = 4.79, 95% CI = 4.35-5.27), and longer length of stay (OR = 6.12, 95% CI = 5.61-6.68).

Helling, et al (2017)<sup>15</sup> conducted a study with 611 adult patients were admitted with the diagnosis of appendicitis. Out of the total sample size of 611 patients, 306 individuals had straightforward presentations, whereas the remaining 305 patients displayed difficult presentations. The decision to pursue non-operative care was found to have a strong positive correlation with advanced age and a greater duration of time between the onset of symptoms and seeking medical attention. For outcome patients who underwent early surgery experienced a longer LOS ( $5.8 \pm 4.4$  days versus  $3.4 \pm 4.5$  days,  $p < 0.0001$ ), and more readmissions.

## DISCUSSION

Appendicitis refers to the inflammatory condition affecting the vermiform appendix. The appendix is a hollow organ situated at the distal end of the cecum, typically found in the anatomical region known as the right lower quadrant of the belly. Appendicitis is commonly attributed to the occlusion of the appendiceal lumen. The potential cause of this condition may arise from an appendicolith, which refers to a stone located within the appendix, or other mechanical factors. The precise etiology of acute appendicitis is frequently uncertain. When there is an obstruction in the lumen of the appendix, it results in the accumulation of bacteria within the appendix, leading to the development of acute inflammation accompanied by perforation and the formation of an abscess.<sup>3,11</sup>

The etiology of appendicitis is commonly attributed to the blockage of the opening of the appendix. The cause of the blockage may vary across different age groups. Lymphoid hyperplasia is a crucial physiological process; yet, it can lead to inflammatory responses, localized ischemia, perforation, and the formation of a confined abscess or complete perforation, subsequently resulting in peritonitis. The obstruction can arise from various factors, including lymphoid hyperplasia, parasite infections, fecaliths, as well as benign or malignant tumors.<sup>3,16</sup>

Appendicitis occurs when an obstruction causes a rise in intraluminal and intramural pressure, leading to the blockage of tiny blood vessels and the stagnation of lymphatic flow. After being blocked, the appendix undergoes mucus accumulation and subsequent distension. As the obstruction progresses, compromising the lymphatic and vascular supply, the appendix's wall experiences ischemia and necrosis. Bacterial overgrowth subsequently ensues within the obstructed appendix, wherein aerobic organisms exhibit predominance during the initial stages of appendicitis, while a combination of both aerobic and anaerobic species becomes prevalent as the condition progresses.<sup>2</sup>

Typical microorganisms encompass *Escherichia coli*, *Peptostreptococcus*, *Bacteroides*, and *Pseudomonas*. When there is a notable occurrence of inflammation and necrosis, the appendix becomes susceptible to perforation, which can result in the formation of a localized abscess and potentially frank peritonitis. The retrocecal position is the most frequently observed location of the appendix. Although the physical position of the base of the appendix remains relatively consistent, the positioning of the appendix's distal end, or tail, can exhibit variability. Potential locations encompass retrocecal, subcecal, pre- and post-ileal, as well as pelvic positions.<sup>16</sup>

The original description of acute appendicitis in relation to its natural history and course was provided by Reginald H. Fitz in 1886. Subsequently, there has been a widespread acceptance of the notion that when appendicitis is left untreated, it can advance to a state of perforation, which is known to be linked with substantial elevations in morbidity, mortality, duration of hospitalization, and utilization of resources. The presence of complicated appendicitis typically amplifies the likelihood of experiencing surgical complications.<sup>17</sup>

Hence, the present discourse delves into novel approaches, namely nonsurgical intervention and interval appendectomy subsequent to the administration of first antimicrobial therapy. Emerging research conducted on pediatric patients has indicated that the implementation of hydration and antibiotic medication can potentially enable surgeons to postpone surgical interventions without adversely impacting patient outcomes. In addition, empirical studies employing randomized controlled trials have indicated that antibiotic therapy in the absence of surgical intervention is a viable and secure therapeutic modality for cases of acute appendicitis.<sup>11</sup>

Several recent studies have indicated that nonoperative management, specifically the omission of interval appendectomy following antibiotic treatment, may serve as a viable alternative for treating complicated appendicitis. These findings are backed by evidence demonstrating relatively low recurrence rates (less than 10%) of appendicitis or abscess after conservative management, as well as reports of high complication rates (ranging from 12- 23%) in patients who undergo interval appendectomy. Nevertheless, an alternative research study reached the conclusion that interval appendectomy ought to be given significant consideration for individuals aged 40 and above.<sup>18,19</sup>

This recommendation is based on the finding that the incidence of neoplasm in patients aged 40 and above was 10 out of 62 (16%), but it was only 1 out of 27 (4%) for those under the age of 40. In the present investigation, a total of 187 patients, accounting for 14.8% of the sample, were scheduled to receive endoscopic intervention following the administration of initial antibiotic therapy. Out of a total of 187 patients, a proportion of 34 individuals (18.2%) exhibited refractoriness to the initial treatment.<sup>20,21</sup> The individuals underwent a surgical procedure that required immediate attention.<sup>19</sup>

Other retrospective study comparing those who received appendectomy to those who managed their infection non-operatively and underwent EIA. The results indicate that the outcomes of patients treated with AA were statistically similar to those who resolved their infection by non-operative therapy and afterwards underwent EIA. Nevertheless, the non-operative approach proved to be ineffective in treating 25.7% of the patients. When these individuals were taken into account, it was shown that AA had a notably lower occurrence of large bowel resection in comparison to all patients who were first treated non-operatively.<sup>22</sup>

It is possible for appendectomies to have problems like cysts, hematomas, and problems with the wound. Bacteroides may grow on the skin if it gets infected. It's possible to get "stump" or "recurrent" appendicitis if too much of the appendix is left over after an appendectomy. The second episode shows how this can become blocked and attacked in the same way as the first one. After an appendectomy, it is important to make sure that there are very small appendiceal stumps, ideally less than 0.5 cm. It is possible for appendicitis to turn into an abscess and an enterocutaneous fistula if it is not addressed. Different types of peritonitis and sepsis can also happen, which can lead to serious illness and even death.

## CONCLUSION

Research shows the benefits of immediate surgery in patients with complicated appendicitis, including benefits in shortening hospitalization time, subsequent infections, and short-term mortality.

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