Chapter

Complicated Appendicitis: A Surgical Controversy Concerning Risk Factors, Diagnostic Algorithm and Therapeutic Management

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Abstract

By surgeon's perspective, complicated appendicitis is defined as perforated appendicitis, periappendicular abscess, gangrenous appendicitis or peritonitis, noted on radiological studies upon hospital admission, operative reports or pathology results of the surgical specimen. Despite that this clinical condition is truly common in everyday surgical routine, its causes and risk factors are still unclear. Some parameters have been associated with complicated appendicitis, like older age, type 2 diabetes, symptoms for longer duration, appendicoliths/fecaliths, delays in surgery after onset of symptoms and after admission. Furthermore, currently, there is no standard diagnostic algorithm for complicated appendicitis. To be specific, radiological findings lack sensitivity, intraoperative assessment may overestimate it while, histopathological examination is regarded as more specific diagnostic method. In addition, the optimal treatment for complicated appendicitis remains controversial between an immediate surgical operation (laparotomy/laparoscopy) or a trial of nonoperative management. Hereby, by reviewing the current literature, we would aim to clarify the risk factors and the diagnostic procedure of complicated appendicitis as well as to compare the operative management with the conservative one according to the type of complicated appendicitis, the success rate and the postoperative complications.

Keywords: Complicated appendicitis, perforated appendicitis, gangrenous appendicitis, appendiceal empyema, risk factors, diagnosis, non-operative management, open appendicectomy, laparoscopic appendicectomy

1. Introduction

1.1 Definition of complicated appendicitis

Acute appendicitis is one of the most well-known acute abdominal disease and the most frequent one for surgical emergencies, with a lifetime risk of 8.6% in males and 6.9% in females, worldwide, ranging from mild acute appendicitis to fecal peritonitis. The term 'appendicitis' is defined as inflammation of the vermiform appendix,

the most common surgical cause of abdominal pain in children and adults and can be divided into uncomplicated and complicated one. Definition of the exact type of appendicitis is based on examination of the peritoneum and appendix. It is truly crucial as it can determine the preoperative management (conservative treatment or immediate surgery), intraoperative management (appendectomy only, aspiration, lavage, cecectomy) and postoperative one (hospitalization, antibiotic regimen) as well as the rates of postoperative complications and morbidity. The current standard treatment of choice for patients with appendicitis is the surgical appendicectomy, either laparoscopic or open. Emerging evidence report that a non-operative strategy with antibiotics has recently been considered in some cases of [1–3].

Currently, a well-structured and specific definition of complicated appendicitis among surgeons is strongly necessary but not clear yet. Complicated appendicitis is thought as an inflammatory type with rapidly proceeding perforation, necrosis, or both and subsequent abscess formation. It is about 4–25% of all the cases and one-third of patients, who develop appendicitis, are diagnosed with complicated appendicitis at the time of hospital admission. To be more specific, while uncomplicated appendicitis is described as any phlegmonous and catarrhal stage of appendicitis without periappendicular infection, complicated appendicitis is defined as the presence of appendiceal perforation, gangrene, serious periappendicular inflammation, peritonitis, mass formation (a plastron), intraabdominal or pelvic abscess [1–3].

The rate of perforation varies from 16–20%. Moreover, abscess rates have been reported as 1% in non-complicated appendicitis and as 50% following perforated appendicitis [4]. Referring to complicated appendicitis, we describe an acute inflammation of the peritoneum secondary to infection of the appendix. Purulent peritonitis is defined by the presence of purulent fluid and fecal peritonitis corresponds to the presence of fecal matter in the peritoneal cavity. However, operative description of peritonitis has not been described clearly (in particular, the distinction between regional and general peritonitis remains unclear), and can vary from one surgeon to another, but this description has a direct impact on the preoperative, operative and postoperative management of patients [1–3].

The mortality risk of acute non-complicated appendicitis is less than 0.1%, but the risk rises to 0.6% in gangrenous appendicitis. On the other hand, perforated appendicitis carries a higher mortality rate of around 5% [4].

2. Risk factors associated with complicated appendicitis

Factors associated with the presentation of complicated appendicitis have been inconsistently identified. In general, frequently described, non-modifiable predictors of appendiceal perforation include extremes of age with a higher frequency occurring in younger age groups (40–57%) and in patients older than 50 years (55–70%). Perforation rate is higher among men (18% men versus 13% women) and it is usually accompanied with three or more comorbid illnesses [4, 5].

Appendicoliths (known as fecaliths), a non-modifiable risk factor, is estimated in up to 30% of asymptomatic population, have historically been associated with appendicitis and has been shown to increase the risk of complicated appendicitis [5]. However, they can also be asymptomatic. In current studies, the presence of appendicolith is associated with earlier and higher rates of appendiceal perforation in patients with acute appendicitis. Ishiyama et al. reported an association of appendicoliths that were large and present at the base of the appendix with appendiceal perforation and gangrene [6]. Clinical significance of appendicolith that incidentally discovered in patients without symptoms of appendicitis, remains controversial. On one hand, the presence of fecalith in the appendix lumen is an

explicit mechanically obstructive factor related to appendicitis. On the other hand, appendicoliths detected by CT scan without inflammatory signs may be transient without special clinical importance. Pathology appears to be due to appendicolith obstructing the appendiceal lumen leading to infection or inflammation, to intraluminal obstruction, venous and arterial congestion and finally to perforation [5, 6].

An additional proposed association with the development of complicated appendicitis is a longer interval from the onset of symptoms to admission. The time from onset of symptoms to occurrence of complication like, gangrene or perforation, varies from short duration of 1–2 days in children to 3–4 days in adults. Imran et al. proposed the increased odds of perforated appendicitis with greater symptom duration and the presence of an appendicolith [5, 7]. Duration of symptoms, a modifiable risk factor, can possibly determine access to surgical care. Perforation is a major concern when evaluating a patient with symptoms that have lasted more than 24 hours.

Factors like, various laboratory markers or other novel parameters, such as "intraabdominal pressure" and clearly increased levels of inflammatory markers can induce any type of complicated appendicitis [5, 8, 9]. Moreover, diabetes mellitus have also been associated with appendiceal perforation. Delayed diagnosis, and probably a history of diabetic nephropathy, as well as poorer renal function were risk factors for the development of complicated appendicitis in diabetic patients [5].

Finally, the exact role and effect of the anti-platelet drugs on complicated appendicitis is not very clear yet. From our personal experience in our department, we have already investigated an increased association between the usage of oral anti-platelet therapy with perforated and gangrenous appendicitis. Going through the current literature, the effect of anti-platelet drugs on surgical blood loss and perioperative complications has not been studied in depth and the management of surgical patients taking anti-platelet medications is controversial. Chechic et al. study claims that the blood loss is significantly greater in patients with a perforated appendicitis and in patients with an operative time of more than one hour while preoperative use of anti-platelets exists [10].

3. Symptoms of complicated appendicitis

Diagnosis of complicated appendicitis is not always straightforward according to a standard algorithm. Clinical presentation may be atypical. Patients with perforated appendicitis can suffer from significant dehydration and electrolyte abnormalities, especially when fever and vomiting have been present for a long time. The pain usually localizes to the right lower quadrant if the perforation has been walled off by regional intra-abdominal structures but can be diffuse if generalized peritonitis occurs. Complicated appendicitis is usually diagnosed in patients with atypical symptoms (epigastric pain, diarrhea, malaise, lack of anorexia, and history of chronic RLQ pain). It has been demonstrated that a diagnostic approach based mainly on history and clinical examination caused a high percentage of negative appendectomy of between 9.2 and 35%. Other unusual presentations of appendiceal perforation can occur, such as retroperitoneal abscess formation due to perforation of retrocecal appendix or liver abscess formation due to hematogenous spread of infection through the portal venous system [11].

4. Diagnosis

The clinical diagnosis of complicated appendicitis is usually challenging and involves a combination of clinical, laboratory, and radiological findings. Globally,

surgeons follow different criteria and algorithms for classifying patients with complicated appendicitis. Definition of the type of appendicitis is critical, as it determines the type of preoperative management (ambulatory surgery or immediate surgery), intraoperative management (aspiration, lavage), subsequent management (hospitalization, postoperative antibiotic therapy) and postoperative morbidity [12].

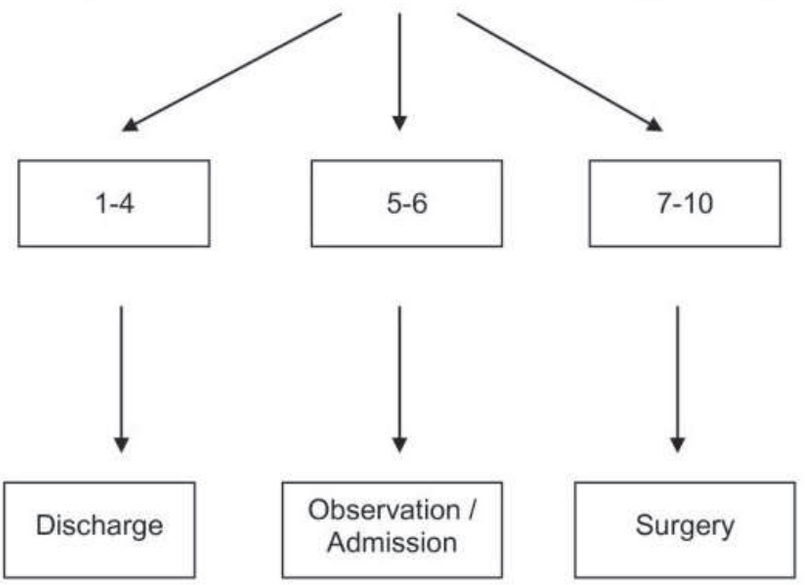
Risk stratification of patients by clinical scoring systems could result in decision-making to reduce hospital admissions, optimize the utility of diagnostic imaging, and reduce negative surgical appendicectomies. Several randomized controlled trials have tried non-operative treatment of uncomplicated appendicitis. Preoperative differential diagnosis of complicated appendicitis from uncomplicated one can be feasible. A false-negative diagnosis of complicated appendicitis may result in severe complications such as abscess or peritonitis, whereas a false-positive diagnosis of uncomplicated appendicitis would result in appendectomy only. The Alvarado (**Table 1**) and AIR scores are standardized diagnostic approaches in evaluating patients with suspected acute appendicitis, using only clinical signs and symptoms and laboratory values. Recently, the appendicitis inflammatory response score (AIR) has been developed and seems to surpass the Alvarado score in terms of accuracy [8, 13]. Gomes et al. report tried to standardize the definition of complicated appendicitis by classifying appendicitis into 5 grades according to the laparoscopic appearance of appendix and peritoneum (**Table 2**) that has been reproducible by further studies. This score classifies appendicitis based on the description of the appendix and the peritoneum into 5 grades. Grades 1 and 2 correspond to uncomplicated appendicitis and grades 3–5 correspond to complicated appendicitis [14].

Many studies have reported that an increase in white blood cells (WBCs) has been the earliest sign of appendiceal inflammation, while increased CRP has been noted in more advanced stages of appendicitis. Older adults tend to have a diminished inflammatory response, resulting in fewer cases of leukocytosis and less remarkable findings on history and physical examination. One reprospective study investigated the changes in mean platelet volume (MPV), platelet distribution width (PDW), and red cell distribution width (RDW) with the diagnosis of acute appendicitis. There are three parameters related to platelets; plateletcrit (PCT), mean platelet volume (MPV) and platelet distribution width (PDW). MPV is a marker of platelet function and activation, and has been used in diagnosis of inflammatory diseases. WBC elevation and presence of NP support the diagnosis of acute appendicitis [15, 16]. Increased PDW and WBC/neutrophil counts can lead to diagnose cases of acute appendicitis, while MPV and RDW levels were not useful diagnostic markers [17]. Muhammad et al. reported that the diagnostic accuracy of WBCs, INR, TB, and CRP were between 68% and up to 93% indicating that these preoperative laboratory tests were valid for early detection of complicated appendicitis [18].

Diagnosis of complicated appendicitis is still challenging despite the use of ultrasonography, computed tomography scan, and diagnostic laparoscopy. Computed tomography (CT) is generally accepted as the most accurate test for diagnosing acute appendicitis, but its ability to differentiate uncomplicated from complicated one is less satisfactory [19–22]. We have to mention that 17% of appendicoliths were unable to be detected by CT imaging. Despite that CT is regarded as imaging of choice in diagnosing appendicitis because of its increased accuracy and clinical outcomes [23], CT scan has lower sensitivity of identifying complicated appendicitis.

One systematic review and meta-analysis concluded to ten CT features for differentiating complicated appendicitis that include abscess, extraluminal air, appendiceal wall enhancement defect, periappendiceal fat stranding, ileus, periappendiceal fluid collection, ascites, intraluminal air, extraluminal appendicolith, and intraluminal appendicolith. Nine of these features showed higher specificity, but lower sensitivity. To be more specific, periappendiceal fat stranding and

Alvarado score	
Feature	**Score**
Migration of pain	1
Anorexia	1
Nausea	1
Tenderness in right lower quadrant	2
Rebound pain	1
Elevated temperature	1
Leucocytosis	2
Shift of white blood cell count to the left	1
Total	**10**



Predicted number of patients with appendicitis:

- Alvarado score 1-4 - 30%
- Alvarado score 5-6 - 66%
- Alvarado score 7-10 - 93%

Ref: Robert Ohle, Fran O'Reilly, Kirsty K O'Brien, tom Fahey & Borislav D Dimitrov. The Alvarado score for predicting acute appendicitis: A systematic review. BMC medicine 2011, 9:139.

Table 1.
Alvarado score for diagnosis of acute appendicitis.

appendiceal wall enhancement defect showed highest sensitivity, while extraluminal appendicolith, abscess, and extraluminal air showed highest specificity. CT scan findings lack sensitivity in detecting appendiceal perforations. Intraoperative assessment may also overestimate appendiceal perforations by 40% [24, 25]. Current guidelines suggest the conduction of CT scan with intravenous contrast in all elderly patients with an Alvarado score ≥ 5 as it can differentiate uncomplicated appendicitis from complicated one [26].

Laparoscopic grading system of acute appendicitis
• 0 Normal looking appendix
• 1 Hyperemia and edema
• 2 Fibrinous exudate
• 3A Segmental necrosis
• 3B Base necrosis
• 4A Abscess
• 4B Regional peritonitis
• 5 Diffuse peritonitis

Table 2.
Laparoscopic staging system of acute appendicitis [3].

Comparable disappointing results have been reported for ultrasonography, and magnetic resonance imaging (MRI) [27]. Furthermore, there has not been a clinical trial comparing US and CT scanning to suggest that US can be as accurate as CT in the differentiation of complicated and uncomplicated appendicitis.

Imaoka et al. reported that three factors, body temperature ≥ 37.4°C, C-reactive protein ≥4.7 mg/dl, and fluid collection surrounding the appendix on CT, are useful in predicting cases of complicated appendicitis preoperatively and can thus facilitate decisions regarding emergency surgery [28]. Atema et al. reported that the scoring system accurately predicted the complicated appendicitis using a maximum possible score of 22 points based on clinical and CT features and a model was created that included age, body temperature, duration of symptoms, white blood cell count, C-reactive protein level, and presence of extraluminal free air, periappendiceal fluid, and appendicolith [29]. While histopathological diagnosis is regarded as the gold standard, the final report takes many days to become available [30].

To conclude, a total evaluation of the patient and their condition can lead to diagnosis of complicated appendicitis. Naderan et al. concluded that "Bedside evaluation" is a useful, cheap, quick and readily available method for identifying those at risk for developing complicated acute appendicitis [31].

5. Therapy

For over a century, open appendectomy was the only standard treatment of choice for appendicitis. Nowadays, laparoscopic appendectomy has surpassed open appendectomy in everyday usage. A non-operative strategy with antibiotics has recently been favorable in some cases of appendicitis and current evidence suggests that there could be wider applicability depending on its type. Preoperative distinction between uncomplicated and complicated disease is truly crucial to this point before deciding the therapeutic protocol. Cases of complicated appendicitis, which include perforated appendicitis and gangrenous appendicitis, may progress to acute peritonitis, a condition that necessitates emergency surgery regardless of the time of development. In contrast, the short-term risk of perforation in cases of uncomplicated appendicitis, such as catarrhal and cellulitis appendicitis is low, and these cases can be treated conservatively with antibiotics [32].

The optimum management of this disease remains a subject of controversy. Although the role of surgery as primary treatment has recently been questioned, appendectomy remains the treatment of choice. Peritonitis mandates urgent surgery but phlegmon is managed by conservative approach and antibiotic therapy

for couple of. The surgery is gold standard treatment for more than a century because of its low incidence of postoperative complications, early recovery and short hospital stay. Nevertheless, surgical treatment exposes the patient to risks due to general anesthesia and other complications such as surgical site infection, adhesions and intestinal obstruction, incisional hernia, infertility in female and pneumonia. Open surgery had been the gold standard until the last 20 years, when laparoscopic approach has currently become the first choice of most surgeons. Laparoscopic appendectomy has already proved of its advantages like less pain, lower wound infection rate and short recovery period. The period between the onset of symptoms and the decision of surgery is truly important as delayed surgery in complicated cases leads to higher risk of postoperative complications.

The goal is to remove any infected material at the time of appendectomy (open or laparoscopic). To be more specific, open appendectomy for perforated appendicitis usually requires a larger incision to provide adequate exposure for drainage of abscesses and enteric contents. Skin closure techniques include primary closure, loose partial closure, and closure with secondary intention. Because of wound infection rates ranging from 30 to 50 percent with primary closure of grossly contaminated wounds, many advocate delayed primary or secondary closure [33]. However, one meta-analysis showed that, compared with primary closure, delayed closure increased the length of hospital stay by 1.6 days without decreasing the wound infection rate [34]. Our preferred technique of skin closure after an open appendectomy is interrupted permanent sutures for patients with complicated appendicitis and the skin is often left open to close secondarily for patients with general peritonitis. Wounds are typically closed after a laparoscopic appendectomy for perforated appendicitis.

Current evidence shows laparoscopic appendectomy to be the most effective surgical treatment, being associated with a lower incidence of wound infection and post-intervention morbidity, shorter hospital stay, and better quality of life scores when compared to open appendectomy [35]. Open and laparoscopic appendectomy have been compared in over 70 randomized trials and analyzed in many systematic reviews. The laparoscopic approach is superior for a lower rate of wound infections, less pain on the first postoperative day and shorter duration of hospitalization. On the other hand, open appendectomy offers a lower rate of intra-abdominal abscesses and a shorter operative duration [36, 37]. However, there is still a controversy about its use in the management of complicated appendicitis. The main guideline from SAGES is that the indications for appendectomy are identical whether performed laparoscopically or open. Moreover, laparoscopic technique provides an additional advantage in patients in whom the diagnosis of appendicitis is uncertain since it offers inspection of the peritoneal cavity especially for women of childbearing age [37, 38]. Furthermore, laparoscopic appendicectomy is better option for obese patients because of the reduction of morbidity-prone incisions [39]. Also, it has been shown that elderly patients who undergo laparoscopic appendectomy, gain shorter hospitalization [40].

Laparoscopy, which leads to less postoperative pain, a shorter hospital stay, and a quicker recovery, represents the standard of care for appendectomy. The most common postoperative complications, such as wound infection, intra-abdominal abscess, and ileus, vary in frequency between open appendectomy (overall complication rate of 11.1%) and laparoscopic approach (8.7%) [35]. We recommend laparoscopic appendectomy as the preferred surgical technique over open appendectomy for both uncomplicated and complicated acute appendicitis, where laparoscopic equipment and expertise are available. Laparoscopy can be recommended for patients with complicated appendicitis even with higher risk categories, like elderly and obese [40]. For high-risk patients, laparoscopy has proven to be safe

and feasible and was also associated with decreased rates of mortality, postoperative morbidity, and shorter hospitalization [41]. One randomized controlled trial stated that LA in obese patients was associated with reduced mortality, reduced overall morbidity, and shorter operating times and postoperative length of hospital stay, compared to open technique [42].

An alternative minimal invasive surgical method is single-incision laparoscopy, in which all instruments and the laparoscope are inserted through a multi-channel portal placed at the umbilicus [43]. Miyo et al. study claims that Single-site laparoscopic interval appendectomy (SLIA) for severe complicated appendicitis after conservative treatment to restrict inflammation can be safe, feasible, and less invasive than appendicectomy and offers all the advantages of minimally invasive surgery despite its disadvantage of prolonging the hospital stay [44]. A 2017 systematic review showed that laparoscopic appendectomy, compared with open one, reduced the risk of surgical site infection, length of hospital stay, and time to oral intake without increasing the rate of intra-abdominal abscess [45].

According to peritoneal irrigation, it is reported that there is no advantage over suction alone in complicated appendicitis in both adults and children. The performance of irrigation during laparoscopic appendectomy does not seem to prevent the development of intrabdominal abscess and wound infections. Drains are of no benefit in preventing intra-abdominal abscess and lead to longer length of hospitalization, and there is also low quality evidence of increased 30-day morbidity and mortality rates in patients in the drain group. So, we recommend against the use of drains following appendectomy for complicated appendicitis in adult patients [46, 47].

Although appendectomy has been the treatment of choice for patients with appendicitis, conservative treatment is currently proposed as an alternative. Cases of complicated appendicitis with localized abscesses, however, present a lower risk of progression to acute peritonitis [48]. Before 2000, many surgeons used a triple antibiotic regimen consisting of ampicillin, gentamicin, and clindamycin (triple antibiotics) for the management of perforated appendicitis. Monotherapy with piperacillin/tazobactam for intra-abdominal infections has recently been shown to be equally efficacious as traditional triple therapy [49]. Similarly, cefotaxime, a third-generation cephalosporin, has been shown to be equal to the monotherapy schedule of piperacillin/tazobactam in children with complicated perforated appendicitis when combined with metronidazole [17].

The optimal approach to complicated appendicitis with phlegmon or abscess is a matter of debate. Current evidence shows that surgical treatment of patients presenting with appendiceal phlegmon or abscess is preferable to accompanied with antibiotic oriented treatment in the reduction of the length of hospital stay and need for readmissions. Non-operative management is a reasonable first-line treatment for appendicitis with phlegmon or abscess. Percutaneous drainage as an adjunct to antibiotics, if accessible, could be beneficial, although there is a lack of evidence for its use on a routine basis. Studies suggest that percutaneous drainage of appendiceal abscesses results in fewer complications and shorter overall length of stay than surgical drainage [50].

To conclude, the management of complicated appendicitis depends on the general condition of the patient, the nature of perforation and whether an abscess is present on imaging studies. Septic patients or patients with generalized peritonitis require preoperative resuscitation and emergency appendectomy (open or laparoscopically) as well as drainage and irrigation of the peritoneal cavity. Stable patients with perforated appendicitis with symptoms localized to the right lower quadrant can be treated with immediate appendectomy or initial nonoperative management (includes intravenous antibiotics, intravenous fluids as well as bowel rest). An appendiceal abscess <3 cm can be treated with immediate appendectomy

but >3 cm should be treated with intravenous antibiotics and percutaneous drainage first, although appendectomy is required if the abscess is not amenable to drainage. Phlegmon of the right lower quadrant can undergo appendectomy without the need for an ileocecal resection. [50–53]. Non-operative management with antibiotics in combination with percutaneous drainage for complicated appendicitis with a periappendicular abscess, can be a safe and feasible treatment of choice. Operative management of acute appendicitis with phlegmon or abscess is a safe alternative to non-operative management in experienced hands and may be associated with less complications, reduced need for readmissions, and fewer additional interventions than conservative treatment. We believe that the laparoscopic approach can be a treatment of choice for patients with complicated appendicitis with phlegmon or abscess where advanced laparoscopic expertise is available, with a low threshold for conversion [40].

The reported rate of recurrence after non-surgical treatment for perforated appendicitis and phlegmon ranges from 12–24%. Interval appendectomy is recommended for those patients with any recurrent symptoms [40]. Existing studies have shown that laparoscopic appendectomy is superior to open approach in reducing the likelihood of surgical site infection, reducing the need for postoperative analgesics, and providing faster recovery of preoperative functional status.

One postoperative concern related to elderly patients with complicated appendicitis is the need of performing a postoperative colonoscopy. Caecal or appendiceal cancer in patients older than 55–65 years can be present with symptoms of acute appendicitis. An incidence rate of 1.6–36% shows that older patients can suffer from cancer beneath the onset of acute appendicitis. Open appendectomy offers a visual inspection of the bowel. Current guidelines suggest that postoperative colonoscopy in patients older than 65 years can be very useful for the patient follow-up especially, when the patient with the complicated appendicitis has been treated with conservative method or laparoscopic appendectomy [26].

6. Postoperative antibiotic therapy

Currently, there is no standard protocol on the duration of postoperative antibiotic treatment and different antibiotic regimens are used. In patients with complicated acute appendicitis, postoperative broad-spectrum antibiotics are suggested, especially if complete source control has not been achieved. In patients with intra-abdominal infections who had undergone an adequate source control, the outcomes after fixed-duration antibiotic therapy (approximately 3–5 days) are similar to those after a longer course of antibiotics. The meta-analysis by Van den Boom et al., including nine studies with more than 2,000 patients with complicated appendicitis, revealed a statistically significant difference in incidence between the antibiotic treatment of ≤5 vs. > 5 days, but not between ≤3 vs. > 3 days [54, 55].

According to current guidelines, patients should not receive postoperative antibiotic therapy in the absence of peritonitis, patients should receive 48–72 hours of postoperative antibiotic therapy in the presence of regional peritonitis, patients should receive 5 days of postoperative antibiotic therapy in the presence of diffuse peritonitis, and patients should receive 7–10 days of postoperative antibiotic therapy in the presence of fecal peritonitis [56]. Although most surgeons agree that appendicitis with perforation, intra-abdominal abscess, or purulent peritonitis can be defined as complicated one, for which postoperative antibiotic therapy is indicated, there is still a considerable variation in the indications for prolonged antibiotic therapy after appendectomy, and the antibiotic regimen that should be used. One cohort reports that operative surgeons accurately identified patients with

complicated appendicitis who did not require post-operative antibiotics. Two days of treatment was associated with reduced complications compared with shorter or longer antibiotic courses [57]. Many studies show that 3 days of postoperative antibiotic treatment is feasible and safe [58]. Three to five days of intravenous antibiotics is recommended for perforated appendicitis after appendectomy. Patients with complicated appendicitis should receive preoperative antibiotics and continue therapy for at least five days. The most common pathogenic organisms isolated after appendectomy are anaerobic and aerobic gram-negative enteric organisms like Bacteroids fragilis and E.Coli and Staphylococcus species [59]. Every patient who responds to initial antibiotic therapy can be discharged with oral therapy to complete a 7 to 10 day course [50–52].

If the surgeon classifies the type of appendicitis as complex, antibiotic prophylaxis should be continued after surgery. This aims to prevent infectious complications, including recurrent intra-abdominal infections. The available guidelines recommend to extend prophylaxis for 3–7 postoperative days [34, 60]. Five days of antibiotics, switched from an intravenous to oral route as early as 48 h after surgery, is common use in many centers. Another strategy, which is gaining ground, consists of 3 days of intravenous antibiotics only. Intravenous regimens most used are cefuroxime or ceftriaxone in combination with metronidazole [9, 58].

7. Postoperative complications

Up to 35% of patients who undergo appendectomy for complicated appendicitis are reported to have post operative complications such as surgical site infections, ileus and bowel obstructions. Some 25–30% of all patients with appendicitis have a complex appendicitis, which is associated with increased risk of postoperative infectious complications. Rogers et al. published a call for a standardized definition of perforated appendicitis. In this study, the postoperative abscess rate after surgery for perforated appendicitis (20.9%) was significantly higher than that published for perforated appendicitis (7.6%), which was lower than published in the 18 most recently published studies (14.4%). Rogers et al. reported that this marked variation in the postoperative abscess rate was due to the lack of a clear definition of perforated appendicitis [61]. Complicated appendicitis has been associated with a significant risk of postoperative septic complications, including wound infections and intra-abdominal abscess formation. Wound dehiscence and fecal fistula are rare but difficult complications of the disease following surgery. Most of the complicated cases require some resuscitation and stabilization with intravenous fluids, and combination of antibiotics before they proceed to surgery. A patient with an appendicular mass is usually treated with antibiotics and observed for development of complications. Of concern is the high complication rate, about 40% of the patients had complicated appendicitis [62]. Complications include wound infection, post op ileus, intra abdominal abscess formation, wound dehiscence, post op intestinal obstruction and rarely enterocutaneous fistula. Surgical site infection (SSI) is one of the commonest postoperative complication seen after appendicectomy, especially for a complicated appendicitis. Surgical-site infection rate was significantly lower in the laparoscopic than in the open group (1.6% vs. 3.2% respectively). The study by Kim et al., showed that untreated acute appendicitis frequently progresses to perforated appendicitis with an increased risk of complications. 23 The time of presentation to the hospital from onset of pain also is a factor to be considered with respect to complications. The more the delay, the higher the incidence of complications. Despite new and better antibiotics, advances in imaging and supportive care, a large number of patients with acute appendicitis develop serious complications

and have morbid and prolonged recoveries. Patients with perforated appendicitis often develop an ileus postoperatively regardless of the surgical approach (open versus laparoscopic).

Immediate surgery in patients with long duration of symptoms and phlegmon or abscess formation has been associated with increased morbidity, due to dense adhensions and inflammation. Complications such as postoperative abscess or enterocutaneous fistula may ensue, requiring an ileocolectomy or cecectomy. A 2010 meta-analysis showed that initial nonoperative management of perforated appendicitis with abscess or phlegmon is associated with fewer complications and similar hospitalization and duration of antibiotic therapy in comparison with immediate surgery [50–52]. It is worth to mention that it has been reported that elderly patients with surgical treatment of complicated appendicitis face increases postoperative complications and longer hospitalization as well as lower rates of successful laparoscopic appendicectomy [26].

8. Conclusions

The distinction between complicated and uncomplicated appendicitis and between regional and diffuse peritonitis is the key to the management of appendicitis (ambulatory surgery, need for postoperative antibiotic therapy, duration of antibiotic therapy and information to the patient about the risk of postoperative complications). Complicated appendicitis with gangrene, perforation and abscess form a considerable proportion of all cases of appendicitis. Simple appendicitis has minimal morbidity, whereas complicated cases are associated with postoperative complications. Delay in presentation due to any reason is one of the factors associated with complications. Majority of delayed presentation is seen in children. Most of the cases occur in less than 40 years of age. A combination of history, examination, laboratory tests, and radiological investigations are preferable for the diagnosis. Although diagnosis is clinical, high leukocyte count correlates with complications. Ultrasound is still the investigation of choice for early diagnosis, though CT scan is diagnostic in doubtful cases. Early surgical intervention is the definitive treatment after initial resuscitation. Post operative antibiotics are necessary to avoid infectious complications. Wound infection and paralytic ileus are the common complications following surgery. Overall morbidity is considerable, but mortality is less than 1% and the general overall outcome is good with early intervention.

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