***Review Article***

**Updates on the management of complicated appendicitis: Review article**

**Abstract**

The diagnosis and management of complicated appendicitis is not uniform due to the absence of any consensus. The diagnosis involves the combination of clinical examination, blood parameters, and imaging modalities like ultrasound and computerized tomography. The management can be divided into conservative treatment and immediate appendectomy. The presence of appendicolith is an indicator of recurrent attacks and hence the need for performing an interval appendectomy. In this review article, we will look at the current diagnosis and management of complicated appendicitis, including the role of conservative treatment and also laparoscopic and interval appendectomy.

Keywords- “Appendicular Mass”,” Appendicolith”,” Appendectomy”, “Complicated Appendicitis”, “Gangrenous appendicitis,” Interval Appendectomy “and “Laparoscopic Appendectomy”.

**Introduction**

Acute appendicitis is one of the most common conditions that cause acute abdominal pain that is presented to the emergency department. The incidence of acute appendicitis is about 50 per 100,000 population and it is mostly seen in the 20-to-30-year age group. The definition of complicated appendicitis involves the common component of perforation of the appendix which may or may not include non-perforated gangrenous appendicitis, the presence of fecolith or acute appendicitis with the presence of pus, acute peritonitis, or abscess formation. The management of complicated appendicitis is still a matter of debate with some advocating for conservative treatment and some for immediate appendectomy(1). In pediatric patients, the definition of complicated appendicitis is a perforation, a hole in the appendix, or fecalith in the appendix. The presence of both is often associated with abscess formation(2).

The use of imaging modalities like ultrasound and computerized tomography has seen complicated appendicitis being associated with extraluminal appendicolith, abscess formation, appendiceal wall defect, extraluminal gas, ileus, peri- appendiceal or free intra-peritoneal fluid or severe peri-appendiceal inflammation or phlegmon. The morbidity from complicated appendicitis is about 20.7% and this highlights the importance of early diagnosis and treatment(3).

The introduction of laparoscopic appendectomy has seen a push towards immediate appendectomy as those patients who had undergone conservative treatment were associated with a high recurrence rate. The need for performing an interval appendectomy after conservative treatment is also an area of controversy with a move away from performing it as a routine and only indicated for patients who develop recurrence(4). The management of complicated appendicitis in the pediatric population is also an area of controversy with the role of conservative treatment depending on the clinical situation of the patient and the presence of diffuse peritonitis is usually associated with performing an immediate appendectomy. The role of performing an interval appendectomy in the pediatric population is also an area of concern(5).

The presence of an appendicolith is associated with an increased incidence of failure of conservative treatment of complicated appendicitis and is an indicator for performing an interval appendectomy. This is important in deciding the timing of surgical intervention(6). The appearance of an appendicolith in pediatric patients who present with acute appendicitis is associated with an increased risk of complicated appendicitis and its associated complications(7).

As there is no current consensus in the management of complicated appendicitis, we have conducted this review article looking into the risk factors for complicated appendicitis like appendicolith, gangrenous appendicitis and management of complicated appendicitis. We conducted a literature review using PUBMED, the Cochrane database of systemic reviews, Google scholar and semantic scholar looking for randomized control trials, non-randomized trials, observational and cohort studies, clinical reviews, systemic reviews, and meta-analysis from 1995 to 2025. The following keywords were used, “complicated appendicitis”, “appendicular mass”, “appendicolith”, “appendectomy “, “laparoscopic appendectomy” ”gangrenous appendicitis” and “interval appendectomy”. All articles were in English, and all articles were assessed by manual cross referencing of the literature. Commentaries, case reports and editorials were excluded from this review. Adult and pediatric patients with complicated appendicitis were included in this study and pregnant patients with acute appendicitis were excluded.

**Discussion**

**Appendicolith and gangrenous appendicitis**

The presence of an appendicolith that is detected on imaging modalities like ultrasound and computerized tomography is associated with a higher risk of failure of conservative treatment of complicated appendicitis. They are associated with a higher risk of perforation of the appendix and these patients will require an appendectomy(8,9). A retrospective study by Sula et al showed that a larger appendicolith diameter, an appendicolith located at the base of the appendix, and heterogenous appendiceal wall enhancement around the appendicolith were associated with a higher risk of complicated appendicitis(10). A retrospective study by Lee et al on the impact of appendicolith on the natural history of acute appendicitis is also associated with a higher risk of complications(11). Kaewlai et al assessed the accuracy of computerized tomography in diagnosing complicated appendicitis from the size of the appendicolith, with a diameter of 4mm – 6mm associated with a sensitivity of 82.7% to 85.3% in detecting complicated appendicitis(12).

Mallinen et al histopathologically assessed those patients who had undergone an appendectomy for an appendicolith that was detected preoperatively and this study showed that the patients with appendicolith-associated complicated appendicitis were associated with histologically significant inflammation of the appendix, micro abscess formation, and increased neutrophilic infiltration. This study confirmed the histological significance of appendicolith with complicated appendicitis(13). Min et al retrospectively assessed the clinical significance of appendicoliths in conservative treatment of acute complicated appendicitis with peri-appendicular abscess. This study concluded that the duration of symptoms and the presence of appendicolith are associated with the increased risk of formation of a peri-appendicular abscess and the failure of conservative treatment of patients with acute complicated appendicitis with abscess formation(14,15).

Gangrenous appendicitis is a term that the operating surgeon uses to describe the appearance of the appendix. There is no standardized definition of gangrenous appendicitis, but some argue that it represents dead intestinal tissue that can physiologically act as perforated appendicitis. There is no consensus on the management of gangrenous appendicitis as some treat them as complicated appendicitis and some do so as simple or non-complicated appendicitis(16). Some have treated patients with gangrenous appendicitis as simple acute appendicitis and the post-operative wound infection rate, and intra-abdominal abscess rates were low. The advantage is that the stay in the hospital and post-operative antibiotic duration can be reduced(17). Gangrenous appendicitis is associated with a higher risk of infective complications, but it is still not considered a risk factor for the development of complicated appendicitis and further studies will be needed to assess its role in the management of acute appendicitis(18,19).

**Diagnosis of complicated appendicitis**

The diagnosis of complicated appendicitis involves the use of clinical examination, blood parameters, and imaging modalities. The common blood parameters include C.

reactive protein, which is a non-specific inflammatory marker, but it has a sensitivity of 40% to 87% and a specificity of 53% to 82%(20). Other markers like increased total white cell count, increased neutrophil to lymphocyte ratio, and white cell lymphocyte ratio can be used but they have varied sensitivity and specificity for diagnosing complicated appendicitis(21,22).

Imaging modalities have been used to differentiate complicated from uncomplicated appendicitis, with ultrasound and computerized tomography commonly used. These imaging modalities though have a high specificity but low sensitivity in diagnosing complicated appendicitis(23). A systemic review and meta-analysis were conducted by Kim et al to analyze the computerized tomography features of differentiating complicated from uncomplicated appendicitis. The features suggestive of complicated appendicitis included appendiceal wall enhancement, the presence of appendicolith, peri appendiceal fluid formation, and ileus. The specificity was 70% -100% but the sensitivity was 14%-59% and this limited the ability of using computerized tomography to diagnose complicated appendicitis on its own(24).

**Table Ⅰ - Table showing the sensitivity and specificity of computerized tomography in diagnosing complicated appendicitis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Study** | **Study type** | **Year** | **Sensitivity (%)** | **Specificity (%)** |
| **Kim et al** | **Systemic review and meta-analysis** | **2018** | **35%** | **80%** |
| **Bom et al** | **Systemic review**  | **2021** | **45%** | **88%** |

**Conservative treatment of complicated appendicitis**

Conservative treatment of complicated appendicitis involves the use of intravenous antibiotics and monitoring of the vital signs, and as the patient's clinical condition improved it was followed by an interval appendectomy in eight weeks. This was done with the belief that immediate surgery would be associated with a higher risk of bowel perforation and fistula formation (25,26). A systemic review and meta-analysis by Andersson et al on the nonsurgical treatment of complicated appendicitis in adults found that the success rate was 92.8% and the recurrence rate was 7.4%. They suggested that conservative treatment without interval appendectomy was recommended for the treatment of complicated appendicitis(27). A meta-analysis by Simillis et al comparing conservative treatment versus acute appendectomy for complicated appendicitis also found that conservative treatment was associated with reduced complication rates, recurrence rates, and length of hospital stay(28).

A systemic review and meta-analysis comparing conservative treatment and immediate appendectomy in the management of complicated Appendicitis in children was conducted by Van Amstel et al. This study showed that conservative treatment was associated with better outcomes than an immediate appendectomy, but the evidence was uncertain, and no recommendations could be made(29). Another meta-analysis was conducted by Vaos et al looking at immediate surgery or conservative treatment for complicated appendicitis in children. This study also showed that conservative treatment was associated with reduced complications and wound infections but there was significant heterogeneity in the studies that were included in this meta-analysis(30).

**Immediate laparoscopic appendectomy for complicated appendicitis**

The introduction of laparoscopic appendectomy has seen a push towards performing an immediate appendectomy for complicated appendicitis. The advantages of laparoscopic appendectomy include the ability to visualize the peritoneal cavity, drainage of pus can be performed, and good visualization of the adnexal structures. The other advantages of laparoscopic appendectomy include faster recovery, reduced post-operative nausea and pain, and early ambulation(31). A systemic review and meta-analysis comparing appendectomy and conservative treatment for complicated appendicitis was conducted by Gavrillidis et al. A total of 1,864 patients were included in this study and 810 underwent appendectomy and 932 conservative treatments. The patients who underwent laparoscopic appendectomy were associated with a shorter hospital stay and there were no differences in the intra-abdominal abscess and wound infection rates(32).

The initial use of laparoscopic appendectomy for complicated appendicitis was associated with an increased intra-abdominal abscess rate but with increased usage, this rate has come down and is comparable with open appendectomy(33,34). A systemic review and meta-analysis comparing laparoscopic and open appendectomy in the management of complicated appendicitis was conducted by Athanasiou et al. A total of 4349 patients were included, of which 2188 underwent laparoscopic appendectomy and 2161 underwent open appendectomy. Laparoscopic appendectomy was associated with reduced morbidity, length of hospital stays, and no significant difference in the intra-abdominal abscess rate(35). A meta-analysis comparing laparoscopic versus open appendectomy in pediatric patients with complicated appendicitis was conducted by Low et al. This study included 3402 patients who underwent laparoscopic appendectomy and 4522 who underwent open appendectomy. The patients in the laparoscopic group were associated with reduced morbidity, analgesia usage, and reduced stay in the hospital. The intra-abdominal abscess rate was however similar between both groups (36).

**Interval appendectomy for complicated appendicitis**

After the completion of conservative treatment for complicated appendicitis, an interval appendectomy was traditionally performed after eight weeks to prevent recurrence. The indication of performing an interval appendectomy was questioned and now it is performed in patients who experience recurrent attacks(37). A systemic review was conducted by Darwazeh et al to see if an interval appendectomy should or should not be performed for patients with complicated appendicitis. A total of 1943 patients were included in this study;1000 patients did not undergo surgery and 543 underwent interval appendectomies. The recurrence rate from the non-operative group was 12.4% and the morbidity was 13.3%, the morbidity rate for interval appendectomy was 10.4%. This study concluded that performing a routine interval appendectomy has minimal benefit (38).

Laparoscopic interval appendectomy was compared to open interval appendectomy by Rashid et al and their study concluded that laparoscopic interval appendectomy was associated with reduced morbidity, postoperative analgesia, and length of hospital stay. Laparoscopic interval appendectomy offers more advantages over open interval appendectomy(39).The risk of appendiceal neoplasm after interval appendectomy for complicated appendicitis was assessed by a systemic review and meta-analysis by Peltrini et al. A total of 8 studies with 480 patients were included in this study, and the prevalence of neoplasm was 11%, with appendiceal mucinous neoplasm being the most common tissue type(40).

**Conclusion**

The diagnosis and management of complicated appendicitis are not uniform due to the absence of proper guidelines on its management. The presence of an appendicolith on imaging may highlight those patients who are at high risk for failure of conservative treatment and may either require an immediate or interval appendectomy. The diagnosis of complicated appendicitis still requires a combination of clinical, laboratory, and imaging to establish the diagnosis. The treatment of complicated appendicitis is slowly seeing a trend toward immediate laparoscopic appendectomy, but this requires the availability of equipment and expertise in performing laparoscopic surgery. Conservative treatment does have a role to play but the need for performing an interval appendectomy will depend on the treatment of the surgeon. The management of gangrenous appendicitis is still an area of concern with most operating surgeons opting to treat it as a complicated appendicitis.

Conflict of interest-There is no conflict of interest

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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