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Review Article

Management of Complicated Appendicitis: The Evolution from Conservative Treatment to Laparoscopic Surgery: Narrative Review Article

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Abstract The management of complicated appendicitis has always been controversial, with no consensus on the management of complicated appendicitis. Complicated appendicitis is defined as perforated appendicitis with or without abscess or phlegmon formation. The management has always been conservative with intravenous antibiotics and bed rest. The emergence of laparoscopic surgery has seen a trend in immediate or early surgery for the management of complicated appendicitis. Due to the absence of any proper guidelines for the management of this condition, the treatment is often decided by the surgeon managing the condition. We have conducted this narrative review article to investigate the current management of complicated appendicitis.

Keywords: Complicated appendicitis, Appendicular mass, Appendicular abscess, Appendicular phlegmon, Laparoscopic appendectomy

Introduction

Acute appendicitis is one of the most common emergencies that is encountered in general surgical practice, with the lifetime risk being 7%-8%. It is seen in patients between the age of 10 to 30 years, and the male-to-female ratio is 1.4:1. The challenge in acute appendicitis is to differentiate uncomplicated from complicated appendicitis. There is no universally agreed definition of complicated appendicitis, although attempts have been made.[1]

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The World Society of Emergency Surgery (WSES) attempted to define complicated appendicitis as perforation of the appendix in the presence of pus or purulent peritonitis or abscess. Most surgeons do agree with this definition.[2]

The European Association of Emergency Surgeons (EAES) defined complicated appendicitis as a gangrenous inflamed appendix with or without perforation, intra-abdominal abscess, peri-appendicular contained phlegmon or purulent free fluid.[3]

An attempt was made to classify complicated appendicitis into 5 grades according to the laparoscopic appearance, including the appendix and peritoneum. But the drawback of this classification is that it can only be made intraoperatively, and hence it has limited clinical use.[4]

A factor in the development of complicated appendicitis is the onset of symptoms to the development of complications like perforation and abscess formation, which varies from a duration of 1 to 2 days in children and 3 to 4 days in adults.[5]

Complicated appendicitis can be classified as 1) perforated appendicitis with abscess formation and 2) perforated appendicitis with phlegmon or appendicular mass. The management of complicated appendicitis has been evolving from conservative treatment, which includes intravenous antibiotics, intravenous fluids, and percutaneous drainage of an appendicular abscess, to surgical options like an appendectomy. The introduction of laparoscopic appendectomy has been slowly replacing open surgery in the management of complicated appendicitis.[5]

As there is no consensus on the definition and management of complicated appendicitis, we have conducted this review article to investigate this. A literature review was made on PubMed and Cochrane databases to look for original articles, observational studies, clinical trials, clinical reviews, review articles, and meta-analyses from 1995 to 2022. The following keywords were used "appendicular abscess", "perforated appendicitis", "gangrenous appendicitis", "complicated appendicitis", "appendicular phlegmon", "ruptured appendicitis", and "appendicular mass". All articles were in English language only, and further articles were obtained by manual cross-checking. Case reports and editorials were excluded. All articles, including adults and children, were included in this review. Pregnant patients with appendicitis were excluded.

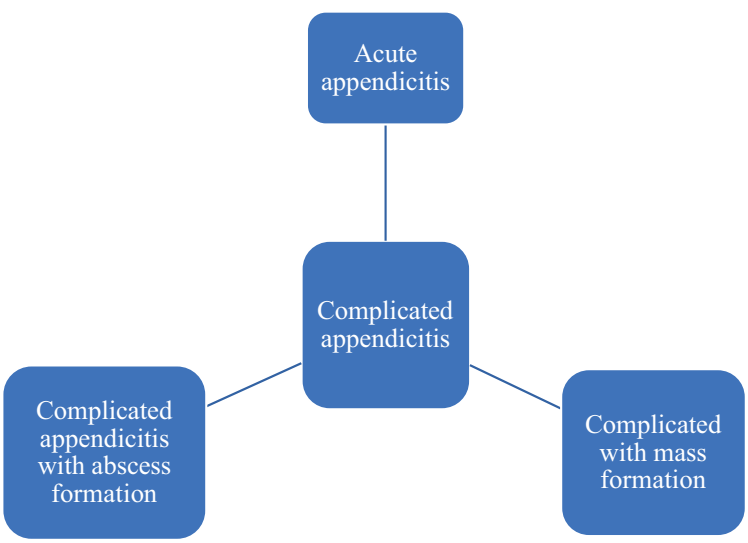

Figure 1 Flowchart for the differentiation of complicated appendicitis

Perforated appendicitis with abscess formation

For patients who present with perforated appendicitis with abscess formation, intravenous antibiotics should be started in these patients. The most common triple therapy includes an aminoglycoside, a beta-lactamase, and a regime covering anaerobes, although there is a growing trend in using broad-spectrum single or double therapy. The duration of antibiotic therapy should be based on clinical criteria and total white cell count. The most common regime is 5-day intravenous antibiotics

followed by 2 days of oral antibiotics. The addition of percutaneous drainage improves the success rate, and this decreases the chances of recurrent appendicitis. Percutaneous drainage is performed with an ultrasound of computerized tomography. The abscess size will determine the need for percutaneous drainage, which may be favored in selected patients. However, due to the paucity of studies, it is recommended that more randomized control trials are needed to determine the precise management.[6,7]

The effectiveness of percutaneous drainage of complicated appendicitis with abscess formation was compared with immediate surgery. These studies were more of a retrospective analysis, and the results showed that percutaneous drainage was effective and safe. The recovery and hospital stay was reduced than those that underwent emergency surgery. This confirmed the effectiveness of percutaneous drainage of appendicular abscess, but the patients may require frequent follow-up.[8-11]

These studies revealed that treatment of complicated appendicitis with percutaneous drainage of the appendicular abscess is highly successful and associated with low complications.

Demetrashvili et al. and Kim et al. conducted retrospective studies on the management of complicated appendicitis, comparing conservative management followed by percutaneous drainage of abscess with immediate appendectomy. The results were the same in both groups regarding infection and recurrence rates. It was concluded that there was no difference in both treatment options, and the surgeon should decide the most appropriate treatment option.[12-13]

Olsen et al. conducted a qualitative systemic review. From a pool of 48 studies and 3,772 patients, showed that conservative treatment and percutaneous drainage of the abscess was the preferred treatment option for children and adults. It was associated with lower complication rates and recurrence rates. The size of the abscess was important, with percutaneous drainage recommended for abscess more than 5cm in size. Operative treatment is reserved for failure of conservative treatment.[14]

Simillis et al. conducted a meta-analysis comparing conservative treatment versus early appendectomy for complicated appendicitis. A total of 16 studies with 1,572 patients were included, 847 underwent conservative treatment, and 725 underwent appendectomy. The conservative group was associated with a lower wound infection rate, reduced abscess formation, and reduced ileus. In conclusion, conservative treatment of complicated appendicitis was associated with decreased complication rates when compared with appendectomy. The drawback of this meta-analysis was the significant heterogeneity of the studies.[15]

Coccolini et al. investigated the management of complicated appendicitis in adults and children. For adults, a systemic review was done looking at the duration of hospital stay, duration of antibiotic therapy, overall complication rate, and reoperation rate. This review included 1,572 patients, of which 847 underwent conservative treatment, and 725 underwent appendectomy. There was no overall difference in the duration of hospital stay; infection rates were the same, except that the reoperation rate was higher in the appendectomy group. This review showed that conservative treatment was associated with decreased complications and reoperation rates. For children, there is no consensus regarding the optimal treatment of complicated appendicitis among surgeons due to the lack of studies like randomized trials, and it was proposed that early appendectomy should be the treatment of choice.[16]

Fugazzola et al. performed a meta-analysis on the management of complicated appendicitis in children. Conservative treatment was compared to immediate appendectomy. 14 studies were included, 2 randomized control trials and 12 observational studies. There was a total of 1,288 patients, of which 622 underwent conservative treatment and 666 immediate appendectomies. This meta-analysis showed that conservative treatment of complicated appendicitis was associated with better complication rates and re-admission rates. The pooled success rate is 90%, and the relapse rate is 15.4%. This showed that conservative treatment of complicated appendicitis should be the first treatment of choice, with appendectomy reserved for failure of conservative treatment.[17]

The conclusion of these studies is that complicated appendicitis with abscess formation is best treated with intravenous antibiotics and percutaneous drainage, which can be done via ultrasonography or computerized tomography. The drawback of these studies was that they were retrospective in nature.

Table 1 Conservative treatment and percutaneous drainage of abcess

Study	N = numbers	Complication rates (%)	Recurrence rate (%)	Study type
Shinde et al.	25	0	0	Prospective study
Cheng Luo et al.	150	5.7	6.79	Retrospective study
Miftaroski et al.	15	13	N/A	Retrospective study
Dementrashvili et al.	23	4.3	13	Retrospective study
Olsen et al.	3,772	0-17	15	Systemic review
Kim et al.	28	15.3	13	Retrospective study
Tingsteldt et al.	50	9	8	Retrospective study

Summary of the studies that involved conservative treatment and percutaneous drainage of appendicular abscess for the management of complicated appendicitis.

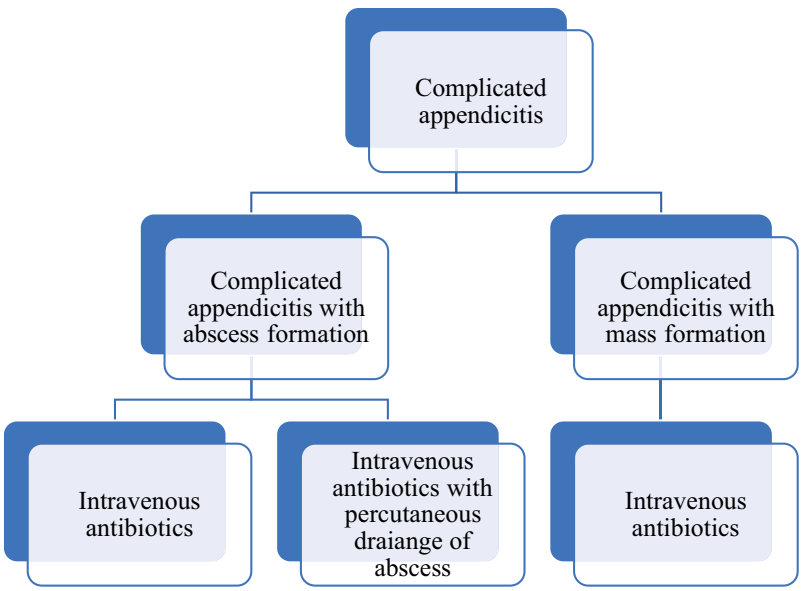

Figure 2 Flow chart on the management of complicated appendicitis

Perforated appendicitis with mass or phlegmon formation

This is defined as a walled-off appendicular perforation which includes the perforated appendix, omentum, and surrounding bowel without an abscess.[18]

The treatment of perforated appendicitis with mass or phlegmon formation was popularized by Ochsner and Sheeren in 1901. The treatment includes keeping the patient nil by mouth and starting intravenous antibiotics. The patient is advised to rest in bed, and upon completion of treatment, the patient will undergo interval appendectomy in 6 to 8 weeks' time. This approach obviates the risk of complications of surgery during the acute phase, and interval appendectomy eliminates the risk of recurrence. This treatment option is still popular in many regions, but it is being challenged by the introduction of laparoscopic surgery.[19]

Yilmaz et al. performed a retrospective study on managing complicated appendicitis, dividing the treatment into conservative treatment and immediate appendectomy. A total of 97 patients were included in the study, 54 underwent conservative treatment, 36 underwent appendectomy, and 7 underwent right hemicolectomy. The recurrence rate was low in this study, and the conclusion of this study was that conservative treatment without interval appendectomy should be the treatment of choice for complicated appendicitis, and interval appendectomy should be reserved for cases of recurrence. The drawback

of this study was its retrospective nature and small sample size.[20]

Elaasdy conducted a prospective study on the management of appendicular mass. A total of 169 patients, of which 121 patients underwent conservative treatment, 106 were successful, and there was a failure of treatment in 15 patients. The remaining 48 patients underwent appendectomy. The study concluded that conservative treatment was a safe and effective treatment, and the recurrence rate was low to justify interval appendectomy. Appendectomy was recommended for patients who present with recurrence, and follow-up with a colonoscopy and computed tomography was preferred for older patients.[21]

Van Amstel conducted a systemic review and meta-analysis on the management of appendicular mass in children.14 studies were included and a total of 1,355 patients, of which 333 were included in the appendectomy group and 1,022 in the conservative treatment group. The complication rate was 25.5% in the appendectomy group and 12.2% in the conservative treatment group. The most common complication was an intra-abdominal abscess in the appendectomy group and failure of conservative therapy in the conservative treatment group. This study concluded that conservative treatment for appendicular mass in children is associated with reduced overall complication rates than an appendectomy, but the evidence is uncertain. The drawback of this review is that it included small retrospective studies.[22]

Gavriilidis et al. conducted a systematic review and meta-analysis on the use of early appendectomy or conservative treatment in the management of appendicular mass.[21] studies were included,[17] retrospective studies, one prospective study, and 3 randomized trials. A total of 1,864 patients, of which 810 underwent appendectomy and 932 conservative treatments. The conclusion was that conservative treatment was associated with lower incidences of wound infection and abscess formation when compared to the appendectomy group. The meta-analysis concluded that the management of complicated appendicitis was controversial and that factors like local infrastructure, surgeons' expertise, and preference influenced its treatment. The drawback of this study was that it was retrospective in nature with a limited number of randomized trials.[23]

Clinical reviews by Becker and Tannoury et al. on the management of complicated appendicitis concluded that conservative treatment was the treatment of choice, and surgery is reserved for cases of failure of conservative treatment. Immediate surgery is associated with a higher risk of abscess formation and wound infection rate. However, immediate surgery is indicated for cases where percutaneous drainage of the abscess is impossible. For patients above the age of 40, follow-up is required with investigations like colonoscopy or computerized tomography.[24-25]

Gillick et al. reviewed the management of appendicular mass in children. 427 patients, of which 411 underwent conservative treatment, and 16 underwent immediate appendectomy. Failure of conservative treatment was seen in 15.8% of the cases, but the incidence of wound infection and recurrence was low. This study showed that conservative treatment followed by interval appendectomy is effective for children's appendicular mass.[26]

Andersson et al. conducted a systemic review and meta-analysis on the conservative treatment of appendicular mass. A total of 20 studies with 59,488 patients were included. The failure rate was 7.2%, morbidity was 13.5%, and the recurrence rate was 8.9% in the conservative treatment group. The conclusion from the meta-analysis showed that conservative treatment of appendicular mass was the treatment of choice, and interval appendectomy was not indicated. Patients should be informed about the risk of recurrence, and follow-up may be required with investigations like colonoscopy and computed tomography.[27]

A systemic review by Teixeira et al. investigated the risk of hidden malignant tumors in patients with an appendicular mass. A total of 13,244 patients were included in this review, and results showed the rate of neoplasms is 10-29% in patients who present with an appendicular mass. The most common tumors are neuroendocrine tumors. A population-based study by Lietzen et al. on the appendiceal neoplasm risk associated with complicated appendicitis showed that the most common tumor was neuroendocrine tumors of the appendix, and the prevalence was 1.24%.[28-29]

The conclusion from these studies was that conservative treatment is successful in the management of appendicular mass, and interval appendectomy is not generally required but is reserved in patients who present with recurrence. The risk of missing hidden malignancies after conservative treatment is also low. The major drawback of these studies was that they were retrospective in nature.

Table 2 Conservative treatment with mass

Study	N = numbers	Success rate (%)	Complication rate (%)	Recurrence rate (%)	Study type
Elaasdy et al.	121	88	9.5	6	Retrospective study
Van Amstel et al.	1,365	88	12.7	34	Meta-analysis
Gillick et al.	427	84	2.3	15.8	Meta-analysis
Anderson et al.	59,488	92.8	2.3	15.4	Meta-analysis

Summary of the studies that favor conservative treatment of complicated appendicitis with mass.

Interval appendectomy after conservative treatment

Upon successful completion of conservative treatment of complicated appendicitis, interval appendectomy is usually done after 8 to 12 weeks' time to prevent recurrence and so as not to miss any other diagnosis like tuberculosis or Crohn's disease. Prospective studies were done for conservative treatment without interval appendectomy. The recurrence rate was 2%, and the success rate was 86.4%.[30]

The role of interval appendectomy is now being questioned as most patients who have undergone successful conservative treatment can be followed up with investigations like computerized tomography and colonoscopy. Interval appendectomy is reserved for patients who present with recurrent symptoms.[31-32]

The assessment of the severity of recurrence appendicitis was retrospectively done by Dixon et al., who concluded that the recurrent attacks were milder and could be treated effectively by interval appendectomy.[33]

Al-Qahtani et al. concluded that interval appendectomy could be used selectively for patients who only present with recurrent symptoms and need not be done as a routine.[34]

The pathological findings following interval appendectomy by Fouad et al. showed that chronically inflamed appendix was the most common finding, followed by acute on chronic inflammation of the appendix and appendicular fecalith. They were no neoplastic lesions reported.[35]

The presence of appendicolith also affects the success of interval appendectomy in children after the completion of conservative treatment. The study by James et al. showed that patients with appendicolith were associated with a higher risk of treatment failure and earlier admission for recurrent symptoms.[36]

The predictors of recurrent attacks of appendicitis after conservative treatment are persistent symptoms after recovery and the presence of appendicolith on imaging; hence interval appendectomy will be required in these patients.[37]

These studies conclude that interval appendectomy is only indicated for patients who present with recurrent symptoms and does not need to be performed as a routine.

Open appendectomy and laparoscopic appendectomy for complicated appendicitis

Bahram conducted a prospective study on 46 patients who underwent immediate appendectomy for complicated appendicitis. The superficial and deep wound infection rates were low, and the mean hospital stay was 3 days. The conclusion from the study was that early appendectomy was feasible for the management of complicated appendicitis and was safe. It avoids the consequence of missing the diagnosis.[38]

Retrospective studies were done to investigate the role of immediate open appendectomy in the management of complicated appendicitis. The wound infection rates and length of hospital stay were comparable to patients who had undergone conservative treatment. The conclusion of the studies was that immediate appendectomy was a safe and effective alternative to conservative treatment of complicated appendicitis. The improvements in surgical technique and post-operative care have made immediate surgery a better option for conservative treatment in the management of complicated appendicitis.[39-41]

Israr et al. performed an observational study on 60 children who were presented with complicated appendicitis. All the patients had undergone an immediate appendectomy, the wound complication rates were 23%, and the mean hospital stay was 4 days. The conclusion

from this study was that immediate appendectomy was a safe and feasible option in the treatment of complicated appendicitis.[42]

Kim et al. undertook a retrospective analysis of the cost-effectiveness and outcomes of conservative treatment and immediate appendectomy in the management of complicated appendicitis. 79 patients were diagnosed with complicated appendicitis, 43 underwent conservative treatment, and 36 underwent immediate appendectomy. The morbidity and mortality were the same in both groups, but the cost of immediate surgery was much less than those patients who underwent conservative treatment. The conclusion of this study was that immediate appendectomy should be an option for the treatment of complicated appendicitis.[13]

Several retrospective studies on the management of complicated appendicitis with laparoscopic appendectomy were done to investigate its efficacy, wound infection rates, and length of hospital stay. The postoperative infection rates were low, and the average hospital stay was 4 to 6 days. The advantages of laparoscopy were that the visualization of the peritoneal cavity was better and post-operative pain was less. The patients were also able to mobilize and ambulate better. The risk of adhesion formation was much less. This study showed that laparoscopic appendectomy is safe and feasible in the management of complicated appendicitis. The drawback of this study was the low patient numbers and the retrospective nature of the studies.[43-49]

Several prospective studies were done to look at the efficacy of laparoscopic appendectomy in the management of complicated appendicitis. The wound infection rate was lower in the laparoscopic appendectomy group, but the duration of the operation was longer. The studies concluded that laparoscopic appendectomy could be performed safely with low post-operative complications and a faster recovery. Laparoscopic appendectomy can be used in the management of complicated appendicitis.[50-54]

Cheng Yu et al. conducted a systemic review and meta-analysis on the feasibility of laparoscopic appendectomy for the management of complicated appendicitis.16 studies were included in 2 randomized control trials and 14 retrospective cohort studies. The study showed that laparoscopic appendectomy could reduce the surgical site infection rate, but the rate of post-operative abscess formation is the same. The length of operative time was longer in the laparoscopic appendectomy group, but the length of hospital stay was reduced. This study concluded that laparoscopic appendectomy was feasible and safe in the management of complicated appendicitis. The limitations of this study were that most of the studies were retrospective in nature.[55]

Guler et al. performed a prospective study on the development of postoperative wound infection in patients with complicated appendicitis who underwent open and laparoscopic appendectomy. A total of 103 patients with complicated appendicitis were included. 59 underwent laparoscopic appendectomy and 44 open appendectomies. The post-operative wound infection rate was 15.9% for those who underwent open appendectomy and 6.8% for the laparoscopic appendectomy group. This study showed that laparoscopic appendectomy is associated with decreased incidence of post-operative wound infection in the management of patients with complicated appendicitis.[56]

These studies concluded that immediate laparoscopic appendectomy should be indicated in the management of complicated appendicitis as it is associated with better outcomes and reduced cost. The drawback of these studies was that they were retrospective in nature, and further randomized trials may be needed to evaluate this.

Table 3 Complicated appendicitis with immediate appendectomy

Study	N = numbers	Complication rate (%)	Study type
Bahram et al.	46	17	Prospective nonrandomized study
Kaya et al.	47	27	Retrospective study
Das et al.	48	-	Retrospective study
Israr et al.	60	23	Observational study
Deelder et al.	34	17.6	Retrospective study

Summary of the studies that performed immediate open appendectomy for complicated appendicitis.

Table 4 Laparoscopic appendectomy for complicated appendicitis

Study	N = numbers	Complication rate (%)	Study type
Chowdhury et al.	30	6.7	Prospective observational study
Thambidurai et al.	51	2.1	Retrospective study
Galli et al.	106	1.9	Retrospective study
Rai et al.	91	5.6	Retrospective study
Shindholimath et al.	19	15.7	Retrospective study

Summary of the studies on laparoscopic appendectomy for complicated appendicitis

Conclusion

The conclusion that we can gather from the evidence is that there is no uniform guide on the management of complicated appendicitis. The management can be divided into conservative treatment, including intravenous antibiotics and percutaneous abscess drainage. Operative management in the form of open or laparoscopic appendectomy is becoming popular, but due to a lack of randomized clinical trials, there is no consensus on the management of this condition. The world society of emergency surgeons (WSES) recommended that if laparoscopic surgery is available, then immediate surgery showed be offered in the management of complicated appendicitis. Due to the absence of any proper guidelines on the management of complicated appendicitis, the treating surgeon will still decide on the management of this condition.

It is my recommendation that all cases of complicated appendectomy should be managed with laparoscopic appendectomy where possible and conservative treatment is reserved in cases where there is non-availability of laparoscopic services.

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