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Chapter 5

Pediatric Advanced Appendicitis

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Abstract

Introduction: Advanced appendicitis (perforation, mass, or abscess) is a significant cause of morbidity in children. This chapter reviews the risk factors for and the management of children with advanced appendicitis and associated complications.

Methods: A search of the literature was conducted and manual cross-referencing was performed.

Results: The incidence of perforation and outcomes vary according to age, gender, and geographical region. Advanced appendicitis is unlikely in the presence of a normal white blood cell (WBC) or C-reactive protein (CRP) measurement. The presence of fever, symptom duration > 24h, generalized abdominal tenderness, rebound tenderness and or rigidity, hypoactive and/or absent bowel sounds, right lower quadrant mass, leukocytosis, and fecalith on CT scans may suggest advanced appendicitis. Age, increased BMI, diarrhea, inadequate antibiotic therapy, and certain microbial isolates may predispose an individual to an increased risk of post-appendectomy complications.

Discussion: Non-operative, operative, and postoperative management strategies in the treatment of pediatric advanced appendicitis are discussed. The key to reducing complications is early diagnosis of advanced appendicitis, which is aided by robust decision-making, biomarker analysis, and the judicious use of imaging.

Conclusion: An up-to-date review of the risk factors for and management of children with advanced appendicitis and complications is presented.

Conflicts of interest: None

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Introduction

This chapter will focus upon the risk factors, diagnosis and management of pediatric (excluding neonatal) advanced appendicitis. By definition, advanced appendicitis includes perforation of the appendix, as well as the presence of an appendicular mass or a peri-appendicular abscess. [1] Perforation refers to a hole in the appendix or the presence of a fecalith in the abdomen. [2] Advanced appendicitis in children leads to an increased risk of postoperative complications (wound infection, intra-abdominal infection, ileus, pneumonia, and urinary tract infection), prolonged length of stay, prolonged analgesic and antibiotic use, increased readmission rate, and increased mortality. [3-10] As advanced appendicitis leads to complications, the primary focus of management should be on early recognition and diagnosis. [11] An early diagnostic strategy may allow for triage with limited resources and informed discussions of the expected pre-, peri- and postoperative clinical course. [12]

Epidemiology and Risk Factors

Advanced appendicitis is a significant health burden. [13] The worldwide incidence of acute appendicitis is estimated to be 86 annual cases per 100,000 people, with approximately 70,000 pediatric cases in the United States alone. [8, 14] The incidence of perforation ranges from 20% [15] to 76% [6, 7] of cases in the pediatric population and masses are palpable on presentation in less than 10% [16] of cases. Post-appendectomy complication rates range from 6.4% [15] to 29.3% [17] with perforation accounting for the majority of those cases. [18-20] Mortality from appendectomies is estimated at 0.5 per 100,000 people. [21]

The incidence of perforation varies according to age, gender and geographical location. [4, 22] For example, African Americans are at an increased risk of perforation compared with Hispanics. [12, 23] Males are more commonly affected than females, while the incidence of perforation is greatest in infants (in one unique series [6], a perforation rate of 100% was reported). [15] The incidence of perforation decreases with the increasing age of children and perforation rates of 51–74% are reported in the 0–5 year old group, 32% among 6-9 year olds, and 27% in the 10 – 14 age group. [5, 6] In another series, one third of patients under the age of three presented with an appendicular mass. [24]

The incidence of perforated appendicitis in children is also influenced by other factors, including access to care and patient-level factors, i.e. socioeconomic status, insurance status, and race. [25-27] However, recent studies show that the health impacts of race and socioeconomic status vanish with equal access to care. [28, 29] Children with a perforation are much more likely to have been initially referred to a pediatrician rather than to a surgeon. [30] There may be an association between obesity and an increased risk of perforation, but not to post-appendectomy complications. [31] There may also be a role played by genetics and familial tendencies. [32]

Pathway to Advanced Appendicitis

The classical pathogenesis of appendicitis is well established. [12, 33, 34] The initiating event is luminal obstruction, typically caused by lymphoid hyperplasia or an obstructing fecalith, and can also be less commonly caused by diet [35-37] and infections. [38-42] The luminal obstruction results in bacterial stasis and overgrowth with resultant distension of the blind-ending appendix (acute appendicitis). With sufficient luminal distension, the intraluminal pressure of the appendix exceeds that of its arterial inflow, resulting in ischemia of the wall (gangrenous appendicitis). A perforation occurs at the site of ischemia with subsequent spillage of pus or a fecalith. The perforation is more likely to be in the presence of and at the site of an obstructing fecalith. [43, 44] The omentum or the small bowel become adherent to the site of perforation and an appendix mass or phlegmon develops. [45] Abscess formation ensues as part of a normal host response to perforation or as a complication of an appendix mass. [12, 46]

The aforementioned description suggests that appendicitis is a progressive condition and thus, delay in presentation or diagnosis will lead to advanced appendicitis. [30, 47-52] Another hypothesis is that a higher perforation rate is found in younger children because of their uniform response to many illnesses and relative inability to express themselves and cooperate. [53] In clinical practice, not all patients with appendicitis will progress to perforation and appendicitis that resolves itself may indeed be a common event. [11, 54] It is highly likely, therefore, that the progression or spontaneous resolution of appendicitis depends on the host response to infection. [11, 55]

Gangrenous Appendicitis

Gangrenous appendicitis had previously been included in the definition of advanced appendicitis. [56] The intestinal lining is intact and is therefore associated with a lower postoperative abscess rate than perforation, abscess, or phlegmon. [56] In contradistinction to the latter, it elicits a divergent immune response. [54, 55] Most cases are treated with resection, requiring only 24 hours of post-operative antibiotics. [56]

Pre-Operative Prediction of Advanced Appendicitis

Clinical Predictors

The risk of perforation increases with a duration of the illness greater than 24 hours. [57] Patients less than eight years of age and male children are more at risk of advanced appendicitis. [15, 58] A history of vomiting, migration of pain, fever, and aggravation of right iliac fossa pain by movement is also associated with advanced appendicitis. [58] The ‘clinical findings’ of a deterioration in general condition, rebound tenderness, abdominal tenderness, muscular tenderness, indirect tenderness, and peritonism also predict advanced appendicitis. [58] Diffuse abdominal tenderness is a non-specific finding. [6] Other associations include a higher oral and rectal temperature, abdominal rigidity, hypoactive and/or absent bowel sounds, and the presence of a palpable right lower quadrant mass. [57, 59, 60] In very young children (under three years), fever, diarrhea, and abdominal distension may often represent a late presentation of perforation. [61]

The 'clinical findings' on examination have better discriminatory power than the history variables in terms of discriminating for advanced appendicitis with receiver operating characteristic (ROC) curve areas of 0.78 to 0.84. [58] Based on the likelihood ratios (LR), advanced appendicitis is unlikely if the patient did not have a fever before the admission (LR 0.32) or if the duration of symptoms was shorter than six hours (LR 0.32). [58] The diagnosis of appendicitis should be doubted when anorexia, nausea, and vomiting are absent, when symptoms have persisted for more than 72 hours without apparent deterioration, or when tenderness in the right iliac fossa is absent. [53] A diagnostic dilemma often occurs in children who are on antibiotic treatment for a presumed respiratory or urinary tract infection or who are suffering from gastroenteritis. [30, 50] Surgical consultation is warranted when the diagnosis is in doubt. [30]

Adjunct Laboratory Tests

Clinical assessment is the subjective appraisal of a patient's reaction to a surgeon's examination. [62] The process cannot be standardized and there is low inter-observer reliability of examination findings. [63, 64] In practice, the distinction by clinical criteria alone is often insufficient and diagnosis, in many cases, will be supported by inflammatory variables and laboratory tests. [58, 62] The inflammatory variables are defined as the white blood cell (WBC) count, peripheral blood mononuclear cell (PMNC) count, PMNC ratio, body temperature, and C-reactive protein (CRP) concentration. [58] Using these criteria, Anderson et al. [58] showed that advanced appendicitis is highly unlikely at the lowest levels of inflammatory variables (WBC < 8 x 10^{-9}/L, PMNC rate < 70 %, PMNC count < 7.0 x 10^{-9}/L, CRP <10 mg/L, temperature < 37.7 ^{o}C) (LR 0.03 – 0.22) and far more likely at the highest levels (WBC ≥ 15 x 10^{-9}/L, PMNC rate ≥ 85 %, PMNC count ≥ 13 x 10^{-9}/L, CRP ≥ 50 mg/L and temperature ≥ 38.5 ^{o}C) (LR 3.44 – 11.15). [58]

> A meta-analysis shows that the WBC and granulocyte count, as well as the CRP level, have a stronger discriminatory capacity for perforated appendicitis (ROC area of 0.85 to 0.87 versus 0.78 to 0.75 for appendicitis). [62] Furthermore, high WBC and granulocyte count and an increased CRP concentration are relatively strong predictors of perforated appendicitis, with a LR^+ of up to 7.20. [62] The study also showed that perforated appendicitis is very unlikely in patients with a low WBC and granulocyte count and a CRP reading of less than 10g/dl, with an LR^- of 0.20 to 0.11. [62]

While the utility of WBC in predicting advanced appendicitis may have been questioned in small retrospective studies, [65, 66] the current evidence from meta-analysis data reveal that a perforation is unlikely when both the white blood cell count and the CRP are normal. [62] Other potential laboratory tests for advanced appendicitis will include serum bilirubin levels, [67] interleukin-6, [68] erythrocyte sedimentation rate, [69] and plasma D-lactic acid [70] assays. The sensitivity and specificity of bilirubin in predicting appendicular perforation range from 38% to 77% and 70% to 87%, respectively. Gofrit et al. [59] reported an association between perforation and an elevated platelet count and low hemoglobin level, but the diagnostic accuracy of these two parameters cannot be ascertained.

Adjunct Radiological Tests

Advances in imaging have improved diagnostic accuracy over clinical judgment alone for the diagnosis of appendicitis. [71] Signs on a computerized tomography (CT) scan that suggest perforation include defects within the appendicular wall, abscess, extraluminal air, phlegmon, ileus, and the presence of an extraluminal fecalith. [23, 72, 73] Each of these CT findings has a specificity of more than 95% for perforations. [73, 74] However, except for cases where multi-detector CT scans have shown a defect in the contrast material-enhanced appendicular wall (sensitivity 95%; accuracy 96.1%), [73] the sensitivity of the other radiological findings are only between 34% and 53%. [73, 74] CT requires contrast administration and patient sedation. [27] Furthermore, the use of this modality in the diagnosis of pediatric advanced appendicitis is not without potential risk to the patient. [75-79] A single abdominal CT study in a 5-year-old child would result in a lifetime risk of radiation-induced cancer of 26.1 per 100,000 in females and 20.4 per 100,000 in male patients. [80] These estimates are derived from probabilistic models designed with data from atomic bomb survivors. [80, 81]

In one retrospective study, the sonographic findings associated with an appendicular perforation were abscess (sensitivity 36.2%; specificity 99%), loss of echogenic submucosal layer of the appendix in a child younger than 8 years old (sensitivity 100%; specificity 72%), and the presence of an appendicolith in a child younger than 8 years old (sensitivity 68.4%; specificity 91.7%). [82] An ultrasound offers the benefit of no radiation exposure, but it is operator-dependent and sensitivity is very limited in a child with a body mass index (BMI) ≥ 25 kg/m^2. [83] Ultrasound scanning is also useful if a mass has been identified on clinical examination and the findings aid in the decision to proceed, for example, with conservative management, operative intervention, or radiological drainage if an abscess were present. [75]

Pre-Operative Predictors of Complications

There is little data that can help to forecast which patients are more likely to develop a postoperative abscess. [84] Postoperative infective complications (abscesses and wound infection) are more likely to occur when the primary antibiotic is inadequate for controlling the offending microorganisms. [85] Based on retrospective analysis of isolates from peritoneal cultures and their relationship to complications, it is obvious that in order to reduce the incidence of complications, the initial broad-spectrum antibiotics should especially cover for *Pseudomonas aeruginosa,* [86, 87] *Streptococcus milleri* [88] and amoxicillin-clavulanate resistant strains of *Escherichia coli*. [85, 89] Retrospective analysis of data from a prospectively collected dataset in children also showed that the risk of postoperative abscess increases with age, weight, body mass index, and diarrhea at presentation. [84]

Management of Advanced Appendicitis

Diagnosis

The morbidity rate from perforation demands that appendicitis be diagnosed promptly in children with abdominal pain. [11, 90] Robust decision-making that incorporates clinical evaluation, biomarker results, and judicious use of imaging is also required. [71] Table 1 presents the key clinical features that may help in the identification of an ‘at risk’ patient. A high index of clinical suspicion is required in presentations with extra-abdominal disorders, such as pneumonia and pharyngitis, as well as in patients who are already on antibiotic treatment for a respiratory or urinary tract infection. [91, 92] A good technique for eliciting clinical signs in children with appendicitis starts with close observation of the child, soothing and distracting their attention. [91] Peritoneal signs become evident if the parent bounces the child up and down, [91] but urinalysis should always be performed. [93] In cases where the classical symptoms and signs are not apparent, the use of ultrasonography is recommended. [30] The overlap of clinical assessment and sonography may give a diagnostic accuracy of more than 80%. [94] The ideal diagnostic imaging strategy should be a staged approach using an ultrasound followed by limited computer tomography, if the ultrasound is inconclusive. [71, 95-97] Specific CT imaging protocols designed to reduce radiation exposure should be employed if the CT is clinically warranted. [91] MRIs are also being evaluated as another diagnostic modality. [98]

Table 1. Potential predictors of Advanced Appendicitis and Complications in Children [6, 12, 15, 57-60, 70, 84, 85, 164]

Predictors of advanced appendicitis
Symptom duration > 24-48 hours
Age < 8-9 years
African-American
Anorexia
Vomiting
Temperature > 38 ^{o}C
Presence of diarrhea
Generalized Abdominal Tenderness
Rebound RLQ Tenderness
Localized RLQ tenderness
Rigidity
Hypoactive bowel sounds
Right lower quadrant mass
WBC > 19,400 cells/microL
Fecalith on CT
Extraluminal air on CT
Abscess on CT
Plasma D-lactic acid > 2.5 mg/dl
ESR > 25 mm/h
Increased band neutrophils
Age
BMI
Diarrhea at presentation
Inadequate empirical antibiotics
Isolated organism on culture

Analgesia

Analgesia should be administered early. Studies including randomized controlled trials show that opioid administration at a dose of 0.05-0.1 mg/kg intravenously does not seem to be associated with a higher risk of management errors. [99-102] In simple terms, analgesia at presentation does not result in an increase of time to the surgical decision for the disposition of patients, [103] potential for loss of peritoneal signs, [100] and does not reduce the surgeons' confidence in their diagnosis. [101]

Empirical Antibiotics

Combination antibiotics [104] were formerly recommended, but recent trials recommend monotherapy with source organism control or single daily regimens (See Table 2). Selected antimicrobials must be effective against both aerobic and anaerobic microorganisms. [105] Predominant organisms include Escherichia coli, Enterococcus, Bacteroides, and Pseudomonas in decreasing order of frequency. [15] Other organisms will include Streptococcal species, [85, 88] Clostria, Peptostreptococcus, Enterobacter, and Klebsiella species. [27] Less expensive broad-spectrum antibiotics may be effective against these microorganisms. [106] Adequate empirical treatment should be started preoperatively in order to minimize the risk of infective complications. [85]

Table 2. Studies providing evidence for antibiotic treatment of appendicitis/peritonitis

S/No	Protocol	Authors
1	Regular dose Ampicillin, Gentamicin and metronidazole	[104]
2	Regular dose Ampicillin, gentamicin and clindamycin	[165, 166]
3	Once daily ceftriaxone and metronidazole	[165]
4	Ticarcillin/clavulanate and Gentamycin	[167]
5	Piperacillin/Tazobactam monotherapy	[147, 168, 169]
6	Cefotaxime and metronidazole combination therapy	[170]
7	Co-amoxiclav, metronidazole and gentamicin therapy	[85]
8	Clindamycin and Ceftazidime	[121]

Scant data exists about optimal duration of post-operative antibiotic treatment. [56] Some authors advocate a predefined duration of antimicrobial treatment based on protocol rather than clinical criteria, whereas others discontinue antibiotics depending on the patient's clinical signs, regardless of the length of the patient's therapy. [56, 107] Empirical antibiotics should be continued for a minimum of 3 days after surgery for advanced appendicitis in children. [107] Treatment courses that last longer than 5-7 days are seldom required following source control. [108]

> Subset analysis from a randomized trial shows that when patients are able to tolerate a regular diet, completing the course of antibiotics orally decreases hospitalization with no effect on the risk of postoperative abscess formation. [84]

Operative Management Strategy

The management of advanced appendicitis in children is controversial. [46] Some surgeons advocate early appendectomy, preceded by a brief period of antibiotic administration and fluid resuscitation. [109] Many authors recommend non-operative management with antibiotics, followed by interval appendectomy, as their treatment of choice. [110-116] Finally, there are those that advocate for non-operative management, with antibiotics and no surgery. [117, 118] Indications for operative management include surgeon preference [105], the presence of fecalith within the abdomen on CT [119], involvement of multiple areas on the pre-operative CT scan [120] and failure of conservative management [121] (persistence of fever after 24 hours of conservative treatment and persistence of bowel obstruction after 72 hours of conservative management). A protocol of urgent, but not emergency, operation is advocated. [122, 123] Overall, the goals of treatment should be to minimize morbidity, costs, hospital stay length, and rate of readmission. [12]

Open Appendectomy versus Laparoscopic Appendectomy

To reduce the risk of post-operative complications, surgeons carefully consider the surgical approach (open or laparoscopic). [106] The laparoscopic approach has been tried in all age groups, including infants [124] and toddlers [125]. The use of minimally invasive techniques in young children should be guided by the individual medical center's resources and protocols, as well as the surgeon's experience and technical expertise. [124, 126] To date, there have been no randomized controlled trials comparing the open and laparoscopic approaches in the management of perforated appendicitis, but multiple studies have established the feasibility and safety of laparoscopic appendectomies. [127] A laparoscopic appendectomy (LA), based on findings from a systematic review, may reduce overall morbidity of advanced appendicitis, but there is an increased risk of postoperative intra-abdominal abscess formation when compared to the open technique in the pediatric population. [17] More recent pediatric studies suggest that LAs do not appear to affect the incidence of abscess formation and that patients with advanced appendicitis are more likely to develop intra-abdominal abscess, regardless of the chosen operative technique. [128] Using the laparoscopic approach for interval appendectomy also has the advantages of minimal morbidity and a very short hospital stay. [129, 130] The operating time is similar to the open procedure. [130]

Intra-Operative Considerations

In cases where a palpable mass is identified under general anaesthesia, some authors advocate a trial of conservative management with no complications in their published series. [110] If surgery is undertaken for advanced appendicitis, the surgeon may encounter an extremely inflamed appendix and caecum, with densely adherent, fragile loops of bowel. [27] In this situation, it may be difficult to safely perform an appendectomy, as injury to other abdominal structures may occur. [27, 131] The surgeon may choose to back out and continue antibiotic treatment or else proceed with what will be a difficult operation. The routine use of surgical drains has not proved particularly useful except perhaps in cases of walled-off abscess cavities. [132, 133] Peritoneal cultures should be obtained if the patient has developed an abscess following antibiotic treatment, because the initial antibiotics may have selected resistant organisms. [27] All fecaliths identified on the preoperative scan must be removed, as a retained fecalith will result in an intra-abdominal abscess that is unlikely to be resolved with antibiotics and drainage alone. [134-137]

Evidence from randomized prospective trials shows that stump closure during laparoscopy may be either by a stapling device or endooops and report no significant difference in morbidity between the techniques in children, particularly with regard to incidence of postoperative intra-abdominal abscess formation. [138] Similar trials also show that pus in the peritoneal cavity can be removed during laparoscopy by suction alone or by irrigation and suctioning, and there is no advantage of one technique over the other. [139] An injection of bupivacaine into the wound significantly reduces postoperative pain. [140] Operative time has no influence on postoperative abscess development. [84]

Wound Closure

Based on reports from Grosfeld [141] and Cruise and Ford [142], surgeons have tended to leave the skin and subcutaneous tissues open in subjects with perforated appendicitis using techniques of delayed primary and secondary closure. [106] This technique, which has been used for subjects of all ages, is much more appropriate for adults, because children experience higher morbidity in the form of pain and anxiety from dressing change than adults. [106] Pediatric surgeons, therefore, would recommend primary closure of all appendectomy wounds in children. [106, 122, 132, 143-147] Infection rates of 0% [143] to 11% [144] have been reported in series of primary closed wounds in children with perforated appendicitis. In one retrospective study, there was no significant difference in wound infection rates related to the method of wound management (primary closure versus skin and subcutaneous tissues left open versus povidone iodine wicks). [106]

Post-Operative Consideration

Septic shock is common, but usually responds promptly to antibiotics, fluids, and other supportive measures. [27] Superficial wound infection rates of 2.4% [148] to 11% [144] and an intra-abdominal abscess rate of 4.4% [148] may also occur, despite using standard prophylactic antibiotics and protocols for wound closure, drains, and surgical discharge. [148, 149] Clinicians should, therefore, warn the parents about this possibility on discharge and advise carers on how to get help.

The use of laboratory evaluation as a component of discharge criteria in advanced appendicitis can stratify a subset of patients who are at increased risk of developing an intra-abdominal abscess and may benefit from continued antibiotic therapy. Postoperative intravenous antibiotics should be continued until patients are afebrile for 24 hours and have a WBC count of less than 12,000/mm3. [106] The absence of leukocytosis on discharge is associated with a decreased risk of post-appendectomy intra-abdominal abscess formation. [150]

A subset analysis from a prospective randomized trial shows that each successive postoperative day with a fever while on intravenous antibiotics is incrementally more predictive of abscess formation and that also, an increased white blood cell count on day 5 may be highly predictive of abscess formation. [84]

The actual diagnosis of postoperative intra-abdominal abscess is made on clinical and radiological grounds and management varies according to the age of the child. [5] A specific radiological search must be made for a retained fecalith in refractory cases and if present, it must be removed by open, laparoscopic, or percutaneous technique. [134, 136] Older children are more likely to require percutaneous abscess drainage and younger children are treated non-operatively, provided that the intra-abdominal abscess was not the result of a retained fecalith. [5]

Non-Operative Management Strategy

Conservative management involves treatment with intravenous antibiotics and close observation of the clinical course of the patient with the early identification of signs of deterioration. [46] During treatment, children are allowed oral fluids and diet, as tolerated and intravenous antibiotics are changed to oral administration as the child’s condition improves. [46] Suitable patients for non-operative management include those patients with symptom duration of more than five days. [151] Antibiotic treatment is indicated for perforated appendicitis with a localized abscess or phlegmon and in selected high-risk surgical patients. [152] For treatment to continue, the WBC count should fall by at least 25% within three to four days of treatment. [153] Successful treatment implies that there is no abdominal pain and the pulse rate and temperature have both returned to normal for at least 48 hours. [46] Intervention is advised if there is an incomplete response after 5 days of conservative treatment. [110] Overall, treatment may fail in 5% to 40% of cases, which results in increased morbidity. [113, 151, 153]

Table 3. Summary of Management of Advanced Appendicitis

Diagnosis
History and Examination
Urinalysis
Laboratory Tests +/- Imaging (US +/- CT)
Management
Analgesia
IV Fluids
Appropriate Empirical Antibiotics
Choice of approach (conservative, open, or laparoscopic)
Technical considerations
Discharge and criteria
Afebrile x 24 h
Wcc < 12,000/microL
Able to tolerate oral feeds

Percutaneous Drainage

Percutaneous drainage is preferable to formal surgical drainage in patients not improving with conservative management and results in a shorter length of hospital stay. [154, 155] It is also an effective primary approach in children presenting with prolonged symptoms and discrete appendicular abscess or phlegmon when treatment is followed by an interval appendectomy. [156] The technique for drainage needs to be carefully selected and the radiation dose minimized due to the increased risk for children. [157] An ultrasound-guided drainage is the preferred approach if deemed suitable.

Table 4. Microorganisms associated with peritonitis due to pediatric appendicitis [15, 27, 85, 88]

Anaerobes
Bacteroides
Clostridial spp
Peptostreptococcus species
Gram-negative aerobes
Escherichia coli
Pseudomonas aeruginosa
Enterobacter
Klebsiella
Gram-positive organism (less common)
Enterococcus
Streptococcus milleri
Group F streptococci
B haemolytic streptococci

Interval Appendectomy

There is no consensus as to whether an appendix associated with a mass that has responded to conservative management should subsequently be removed. [45, 46, 158-161] The evidence is that there is a 5% to 37% risk of recurrent appendicitis and morbidity following conservative management of advanced appendicitis. [114-116] These cases of recurrent appendicitis usually occur within months of initial presentation. [161] Some authors advocate an interval appendectomy in patients with persistent symptoms following recovery from the initial episode and those with a slow resolution of the appendicular inflammatory mass or an ultrasonographic image of an appendicolith. [162] All patients should be told that appendicitis may recur following conservative management and should be encouraged to seek early medical attention when this occurs. [161] Another argument potentially in favour of interval appendectomy is to outrule the presence of malignancy, especially a potential carcinoid tumour, which may be seen in approximately 2 cases per 1000 pediatric appendectomy specimens. [163]

Conclusion

Pediatric advanced appendicitis remains a significant cause of morbidity. The initiating event is usually luminal obstruction by a fecalith. Perforation rates vary according to age, gender, and geographical region. Presentation is often in the form of known symptoms and signs of peritonitis, but atypical presentations may also occur. Patients with increased body mass index and pre-operative diarrhea may be at a higher risk of postoperative complications. The key to reducing complications is an early diagnosis of advanced appendicitis, which is arrived at by a combination of robust decision-making, biomarker analysis, and the judicious use of imaging. Non-operative, operative, and postoperative management strategies based on all the evidence have been described.

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