Management of Complicated Appendicitis in the Pediatric Population: When Surgery Doesn't Cut It

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Abstract

Keywords

- ▶ abscess drainage
- ▶ pediatric
- ▶ appendicitis
- ▶ appendiceal abscess

The management of complicated appendicitis in children has evolved significantly over the last century. What initially was a surgeon's dilemma is becoming the interventional radiologist's task because image-guided percutaneous drainage of abscesses from a ruptured appendix obviates the need for urgent surgery and allows for selective interval appendectomy at the surgeon's discretion (versus conservative nonoperative management in selected cases). This paradigm shift places the onus on the interventional radiologist to recognize when the procedure is emergently indicated and to be cognizant of the special needs of a pediatric patient.

Objectives: Upon completion of this article, the reader will be able to (1) identify indications for emergent drainage catheter placement, (2) identify available procedure options based on abscess location, and (3) name special pediatric considerations (use of nonionizing radiation, sedation, etc.).

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Prolonged symptoms of appendicitis (>72 hours) with delayed presentation are known risk factors for the development of complications such as rupture and abscess formation.^{1,2} This is particularly true in the pediatric population in which the patient may not be able to relay his or her symptoms to the parent or clinician. As such, the interventional radiologist is often called on for emergent percutaneous abscess drainage, a well-established and effective practice in both children and adults.^{3,4} Strategies for procedural planning and for catheter management are discussed here, with special attention to the pediatric population.

Case Presentation

An 11-year-old boy with no significant past medical history presented to the emergency department with a 2-day history of lower abdominal pain and vomiting. He also had intermittent fevers 1 day prior to presentation. On physical examination, he was afebrile but had diffuse abdominal tenderness to palpation, which was most severe in the epigastrium and right lower quadrant. There was also rebound tenderness. A complete blood count revealed leukocytosis of 15.1 K/uL. Initial imaging evaluation with an abdomen/pelvis sonogram was performed. The appendix was not visualized, but an abnormal fluid collection was identified cephalad to the bladder (►Fig. 1).

A contrast-enhanced computed tomography (CT) scan with oral contrast was obtained to further evaluate the appendix and the supraventricular fluid collection. It revealed a dilated, inflamed appendix containing an appendicolith (►Fig. 2). Additionally, there was a loculated fluid collection anterior and superior to the bladder that corresponded to the collection identified on the prior sonogram, as well as a second fluid collection between the bladder and rectum (►Fig. 3). These findings were consistent with perforated appendicitis complicated by abscess formation.

The patient was placed on intravenous (IV) antibiotics. The interventional radiology service was consulted on hospital

Figure 1 (A) Transverse sonogram of the pelvis demonstrates an irregularly shaped fluid collection (asterisk). (B) Longitudinal scanning demonstrates the fluid collection (asterisk) is immediately superior to the bladder.

day 1 for drainage of the pelvic fluid collections, and 8.5F multipurpose drainage catheters were placed percutaneously in both fluid collections under CT guidance (→Fig. 4). Sedation of the patient during the procedure was coordinated with the pediatric sedation service available at our institution. Purulent fluid was obtained from both collections, confirming the diagnosis of periappendiceal abscesses.

The patient improved clinically after drain placement with normalization of serum white blood cell count; he experienced an otherwise uneventful hospital stay. He completed his 7-day course of IV antibiotics and was subsequently discharged on hospital day 7 after drain removal. The patient returned for interval laparoscopic appendectomy 2 months later without incident.

Figure 2 (A) Axial image from a contrast-enhanced computed tomography (CT) scan demonstrates a dilated, inflamed appendix (arrow). (B) An appendicolith (arrow) is present within the distal appendix. (C) Coronal reconstruction from the same CT scan demonstrates the dilated, inflamed appendix (arrow). (D) Coronal reformatted image again demonstrates an appendicolith (arrow) within the distal appendix.

Figure 3 (A) Axial image from a contrast-enhanced computed tomography (CT) scan demonstrates two loculated fluid collections (arrows) anterior to the bladder (B) and between the bladder and rectum (R). (B) Sagittal reconstructed image from the same CT scan demonstrates the fluid collections (arrows) superior to the bladder (B) and between the bladder and rectum (R).

Figure 4 (A) Axial noncontrast computed tomography (CT) scan from the same patient as seen in Fig. 3. Following anterior drain placement, there is proper positioning of a pigtail drain within a fluid collection. (B) CT scan immediately following posterior drain placement demonstrates proper positioning of a pigtail drain within a posterior fluid collection. Note the very medial location of the posterior drain, done intentionally to decrease risk to the sciatic nerve.

Discussion

Diagnosis

Given the stochastic risks of radiation exposure, an emphasis on dose reduction for the pediatric population is justified. This principle was formally promoted with the launch in 2008 of the Image Gently campaign. Accordingly, graded compression sonography is the principal imaging technique for the initial investigation of suspected appendicitis.^{5,6} On ultrasound (US), a noncompressible appendix with a diameter >6 mm is specific for appendicitis (►Fig. 5). Periappendiceal fluid and enlarged lymph nodes may also be seen. An appendicolith appears as an echogenic focus with dense posterior acoustic shadowing (►Fig. 6). Note that appendiceal perforation may occasionally decompress the appendix, underscoring the importance of correlating with the clinical presentation; in fact, the appendix itself is visualized in only 40 to 60% of patients with appendiceal perforation.⁷ As such,

CT is often of greater utility than US in identifying complications of appendicitis such as phlegmon and abscess formation. When compared with US, CT has a high sensitivity and specificity, as well as reduced operator dependence. For example, in the case presented here, the transabdominal sonogram failed to demonstrate the second abscess between the bladder and rectum.

Treatment

Although data are mixed on the management scheme for uncomplicated acute appendicitis, surgery remains the mainstay of treatment in most centers.^{8–10} No universal treatment standard exists when acute appendicitis is complicated by perforation and abscess formation. With the advent of image-guided percutaneous drainage of abscesses, the preferred initial management of these patients has now widely become nonoperative, consisting of percutaneous drainage and broad-spectrum IV antibiotics. This initial conservative

Figure 5 (A) Sonogram of a normal blind-ending tubular structure in the right lower abdomen representing an uninfamed appendix measuring <6 mm in diameter (4.8 mm in this instance). (B) In a different patient, the calipers are measuring an enlarged, inflamed appendix (measuring 8.3 mm) with wall thickening.

approach is usually followed by interval appendectomy,^{11–14} particularly in patients with an appendicolith, because this has been shown to be a predictor of recurrent appendicitis.¹⁵ Livingston et al investigated the epidemiological trends of perforated and nonperforated appendicitis over a 25-year period, and they concluded that they may fundamentally represent two different disease processes. This suggests that appendicitis is a more complex and heterogeneous disease than previously realized.¹⁶

Jamieson et al reported a successful treatment rate of 91% for appendiceal abscesses treated with drainage and IV antibiotics.¹¹ More recently, Marin et al reported similar clinical and technical success rates of 90% with no procedure-related complications. In the 10% of patients who failed nonoperative management, they found that the most specific predictors of clinical failure were a large poorly defined appendiceal abscess and an extraluminal appendicolith.³ These studies

suggest that urgent appendectomy still plays a role in the treatment of perforated appendicitis, especially in patients with life-threatening signs of peritonitis, in patients with a large appendiceal abscess, and in patients with an extraluminal appendicolith. In most cases, however, nonoperative management is both safe and effective.

Percutaneous drainage can be performed under US or CT guidance, using either the Seldinger or trocar technique. US guidance is advantageous in the pediatric population because of its lack of ionizing radiation. It also allows for real-time observation of the abscess during catheter placement. However, US is limited if the abscess is small, obscured by other structures, or if precise placement is required because of nearby vessels or organs. In these cases, CT is the optimal imaging modality.¹⁷

When an abscess is deep in the pelvis, depending on the specific location of the fluid collection and operator preference, access may be obtained via transgluteal, transvaginal, or transrectal approaches.¹⁷ However, the transvaginal approach is generally avoided in younger pediatric patients because of the potential psychological impact.¹⁸ Transgluteal and transrectal approaches are generally well tolerated. If there is suspicion that a fluid collection may be sterile, a transgluteal approach is preferred because it allows for sterile technique.¹⁷

For the patient presented here, the drains were placed under CT guidance because the deep pelvic posterior abscess was not visualized on the antecedent sonogram. Nevertheless, the anterior supravescicular abscess could have been safely accessed by US guidance. At our institution, the preferred method of percutaneous drain placement is via the Seldinger technique. The patient was first placed supine on the CT table for a percutaneous anterior approach to the abscess that was anterosuperior to the bladder. Localization scan with a grid marker overlying the skin allowed for selecting a safe window of access into the collection. A coaxial micropuncture introducer set (Cook Medical Inc., Bloomington, IN) was advanced into the abscess under CT guidance. An 0.035-in × 75-cm superstiff Amplatz guidewire (Boston

Figure 6 The calipers mark an inflamed appendix measuring >6 mm in diameter (7.5 mm) with compression. An echogenic stone (appendicolith, arrow) with posterior shadowing is seen at the appendiceal tip.

Scientific, Natick, MA) was advanced through the 5F sheath and coiled within the abscess. After serial dilatation of the tract with a 7F and 9F dilator, an 8.5F pigtail drain (multipurpose drainage catheter; Cook) was advanced over the guidewire and deployed. A final CT scan confirmed appropriate positioning of the catheter (►Fig. 4A).

The patient was placed in the prone position on the CT table for a posterior transgluteal approach to the abscess between the bladder and rectum. The micropuncture introducer set (Cook) was advanced as medially as possible within the greater sciatic foramen to avoid vessels and the sciatic nerve. An 8.5-F pigtail drain (Multipurpose drainage catheter; Cook) was advanced into the abscess by employing the same technique described above for the anterior abscess (►Figs. 4B).

Special Considerations for Pediatric Patients

Pediatric patients have specific needs that are different from adults. Specific equipment for monitoring and resuscitation of pediatric patients needs to be available in the interventional radiology suite. Pediatric patients have a higher surface area-to-volume ratio, causing them to lose body heat more readily, so any body part that does not need to be exposed during the procedure should be covered to minimize body heat loss. The parents of pediatric patients are also more involved in the care of the patient than in adults.

Young children typically require either deep sedation or general anesthesia during the drainage procedure. A certified nurse and/or anesthesiologist is needed to achieve these levels of sedation.¹⁷ At our institution, the interventional radiology section coordinates pediatric procedures with a dedicated team composed of a supervising critical care physician as well as critical care nurses who undergo an extensive sedation competency process.

When choosing a route for access, a transvaginal or transrectal approach may not be possible in younger patients due to their inability to tolerate such procedures. Furthermore, a transvaginal approach should only be considered in patients who are sexually active, who have had prior pelvic exams, or who have used tampons. When considering a transrectal approach in a young patient, the size of the patient should be evaluated since this route may not be feasible in younger or smaller patients due to a small rectal vault.^{17,18}

Ionizing radiation is more detrimental to young patients than adults. Procedures that can be safely performed under US guidance should be. Repeat CT scans should be limited when evaluating for resolution of an abscess or if the patient is not clinically responding to drainage of an abscess. The management strategy at our institution includes drain removal upon resolution of fever, normalization of leukocytosis, and/or reduction of drain output to < 20 mL/day. Moreover, catheter clogging is suspected by a sudden cessation of output, purulent leakage around the catheter at the skin insertion site, and resumption of fever and leukocytosis. The response to the latter scenario is generally catheter exchange and/or upsizing, particularly if follow-up imaging does not reveal a significant decrease in the size of

the abscess in the face of persistent clinical indicators of infection.¹⁹

Summary

With evidence growing for conservative nonoperative management of acute complicated appendicitis, and with the established safety and efficacy of percutaneous image-guided abscess drainage, the emergency department often looks to the interventional radiologist to aid in the treatment of this disease in the pediatric population. At our institution, these patients are prioritized as emergent in the setting of sepsis and clinical instability and are immediately offered a drainage procedure, whereas stable patients on whom antibiotics have been initiated are categorized as urgent and are safely treated during the regular workday. In addition, our treatment protocol includes collaboration with a dedicated pediatric sedation team in an attempt to optimize patient safety.

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