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## Appendicitis in children less than 3 years of age: a 28-year review

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**Abstract** Appendicitis is the most common surgical abdominal emergency in the pediatric population, but is rarely considered in children less than 3 years of age. The goal of this study was to identify the presenting symptoms and signs in this age group and examine their subsequent management and outcome. A 28-year experience of a single pediatric surgeon in academic practice was reviewed; 27 children less than 3 years old (mean 23 months) comprised 2.3% of all children with appendicitis in his series. The most common presenting symptoms were vomiting (27), fever (23), pain (21), anorexia (15), and diarrhea (11). The average duration of symptoms was 3 days, with 4 or more days in 9 children. Eighteen children were seen by a physician before the correct diagnosis was made; 14 were initially treated for an upper respiratory tract infection, otitis media, or a urinary tract infection. The most common presenting signs were abdominal tenderness (27), peritonitis (24), temperature 38.0 °C or more (21), abdominal distension (18), Leukocytosis ( $< 12.0 \times 10^3/\text{mm}^3$ ) was found in 18, tenderness was localized to the right lower quadrant (RLQ) in 14 and was diffuse in 10. Abdominal radiographs demonstrated findings of a small-bowel obstruction (SBO) in 14 of 21 patients, a fecalith in 2, and a pneumoperitoneum in 1. Contrast enemas were performed in 6 children, 5 of whom had a phlegmon or an abscess. Perforated appendicitis was found in all 27 patients. An appendectomy was performed in 25 and a

RLQ drain was placed in 18. Postoperative antibiotics were administered to 17 children for an average of 6 days. Two patients underwent interval appendectomies, 1 following treatment with IV antibiotics and 1 following surgical drainage. The average time to resume oral intake was 7 days and the average hospital stay was 21 (median 15) days. Sixteen patients had 22 complications, which included 6 wound infections, 4 abscesses, 4 wound dehiscences, 3 pneumonias, 2 SBOs, 2 incisional hernias, and 1 enterocutaneous fistula. Perforated appendicitis was found in all children less than 3 years old, resulting in very high morbidity (59% complications), which may be attributed to the 3–5-day delay in diagnosis. Although appendicitis is uncommon in this age group, it should be seriously considered in the differential diagnosis of children under the age of 3 years who present with the triad of abdominal pain, tenderness, and vomiting.

**Keywords** Ruptured appendix

### Introduction

Appendicitis is the most common condition requiring emergent abdominal surgery in the pediatric population. With an estimated incidence of 4 per 1,000 school-age children per year, it accounts for up to 30% of pediatric presentations to emergency departments with abdominal pain [1, 5]. Although up to one-third of children have the classic presentation of diffuse central abdominal pain followed by vomiting and localization of the pain to the right iliac fossa and pyrexia, these are generally older children [1].

The presentation in preschool children is more often atypical, and tends to be delayed [3, 4, 11], with perforation of the appendix an almost universal finding at laparotomy [3, 4, 11]. This population is often misdiagnosed, and shows greater morbidity [3]. The objective of this study was to review the presenting symptoms and

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signs, management, and outcome of children under 3 years of age who underwent a laparotomy for appendicitis under the care of a single pediatric general surgeon.

## Materials and methods

The Hospital for Sick Children, Toronto, is a tertiary-level pediatric care center. All admissions under the care of Dr. S.H. Ein between 1969 and 1998 inclusive were reviewed. All children under 3 years of age diagnosed with appendicitis who subsequently underwent an appendectomy were included in this study. Confirmation of the diagnosis was made at laparotomy and/or on histologic examination. All available data for these patients were reviewed, including duration of presenting symptoms, signs, laboratory and imaging reports, operative findings, procedures, and postoperative course.

## Results

Twenty-seven children less than 3 years of age underwent an appendectomy for appendicitis during the study period, of whom 4 were under 1 year old; these comprised 2.3% and 0.34%, respectively, of all children with appendicitis over the same time frame. There were 16 boys and 11 girls. The mean age was  $23 \pm 8.4$  months (range 3–36 months). The mean delay from onset of symptoms to presentation to our emergency department was 3 days (range 1–14 days), with 9 children (33%) presenting 4 or more days after the appearance of the first symptoms. Eighteen children (67%) had previously been examined by a physician without a correct diagnosis, and 5 (18.5%) had been seen by two or more physicians. Fourteen children (52%) were treated for either an upper respiratory tract infection, otitis media, or a urinary tract infection.

The most common symptoms and signs at presentation are summarized in Tables 1 and 2. Additionally, 4 children refused to walk. Three patients had a right-sided abdominal mass palpable on examination. Of the 21 patients with fever ( $\geq 38.0$  °C), 12 (57%) had a temperature over 39.0 °C. Eighteen (67%) had leukocytosis, defined as a white blood cell count of over 12,000/mm<sup>3</sup>. Of the 8 children with documented leukocyte differential counts, 7 (87.5%) showed a definite left shift (absolute neutrophil and band-cell percentage > 50%).

Abdominal radiographs were performed on 21 children at presentation, demonstrating a small-bowel obstruction (SBO) in 14 cases (67%), a fecalith in 2

**Table 2** Presenting signs (*RLQ* right lower quadrant)

	No. of patients	Percentage
Abdominal (Abd.) tenderness	27	100%
RLQ (localized)	14	52%
Diffuse peritonitis	10	37%
Fever $\geq 38.0$ °C	21	78%
Abd. distension	18	67%

(0.1%), and a pneumoperitoneum in 1. Contrast enemas were performed in 6 children, of whom 5 had an abscess or a phlegmon. Abdominal ultrasound (US) was performed in only 3 patients, and was interpreted as showing an appendiceal abscess, a SBO, and a normal abdomen, respectively.

An appendectomy was performed in 25 patients, with placement of a right-lower-quadrant drain in 18. Two children underwent an interval appendectomy, 1 following treatment with IV antibiotics and 1 following surgical drainage. A ruptured appendix was uniformly observed at laparotomy. Postoperative antibiotics administered to 17 patients were continued for a mean of 6 days. The average time to resumption of oral intake was 7 days, the median length of hospital stay 15 days (mean 21 days). Sixteen patients (59%) had 22 complications, including 6 wound infections, 4 abscesses, 4 wound dehiscences, 3 pneumonias, 2 SBOs, 2 incisional hernias, and 1 enterocutaneous fistula. No deaths occurred during the study period.

## Discussion

It is an irony of medicine that more than 100 years after it was first recognized, the condition most commonly requiring emergent abdominal surgery in the pediatric population should still retain its diagnostic challenge. Initially described by Reginald Fitz in 1886, the pathophysiology of appendicitis was expanded upon by McBurney in 1889 [4]. Since then, numerous studies have suggested novel clinical and imaging approaches, yet the morbidity of appendicitis in children less than 3 years of age remains astonishingly high [3, 4]. Delayed presentation and misdiagnosis are frequent occurrences in this age group, and have resulted in perforation rates in excess of 90% [4, 11]. Anatomic immaturity, in particular the lack of an adequate omental barrier, may contribute to the rapid progression to perforation and peritonitis in these patients [1].

Particularly in the infant age group, the diagnosis of appendicitis may be overshadowed by concerns of intussusception and other medical conditions [1]. Gastroenteritis (viral or bacterial) is the most common misdiagnosis [4, 11, 9], with a history of diarrhea present in 33% [3] to 41% of patients; indeed, the increased incidence of diarrhea with perforated appendicitis makes it a more prominent presenting feature of the disease in infancy. Since prior illness and inflammatory changes may play a role in the pathophysiology of acute appendicitis

**Table 1** Presenting symptoms

	No. of patients	Percentage
Vomiting	26	96%
Fever	23	85%
Abdominal pain	22	81%
Anorexia	15	56%
Diarrhea	11	41%

[5], diagnosis of a respiratory, urinary, or gastrointestinal infection does not indicate that the picture could not be complicated by acute appendicitis. Therefore, retaining an increased index of suspicion in these cases may lead to a decrease in the number of patients sent away with incorrect or at least incomplete diagnoses. This is particularly relevant in the present study, where 67% of children had been seen by one or more physicians without being diagnosed as having appendicitis.

Various refinements of history-taking and examination techniques have been proposed, including paying closer attention to the relative order of presenting complaints, with a history of abdominal pain preceding vomiting considered suggestive of appendicitis as opposed to gastroenteritis [4]. In this young pediatric population, timely and clear communication of symptoms to caregivers is uncommon, making it difficult to make these distinctions in the history. The child's refusal to walk, although a helpful sign, is non-specific, and in any case is not relevant to the infant population. Grunting respirations, typically thought to relate only to respiratory and metabolic conditions, have previously been suggested as a manifestation of abdominal pathology in these patients [11], but was only noted once in the present study.

Vomiting (96%), fever (85%), and abdominal pain (81%) remain the most common symptoms at presentation in this study and are consistent with the literature [3, 11], but the frequent occurrence of diarrhea was often misinterpreted as gastroenteritis. Although some investigators place much emphasis on the presence of anorexia [4], it was only present in approximately one-half of our cases. The most frequently elicited sign on examination was abdominal tenderness, reported in over 80% of patients in previously published reports [3, 11], with one-half of our patients having signs of localized peritonitis. Abdominal distension was noted in two-thirds of our patients, and is generally felt to be a late sign associated with rupture of the appendix, peritonitis, and SBO [11].

Abdominal roentgenograms (plain and upright) have been recommended in many studies [1, 11, 12] and challenged by others [7]. The incidence of SBO in this study was consistent with previously published figures [11], although identification of a fecalith was less frequent in our experience. While the usefulness of abdominal roentgenograms in older patients may be controversial, the identification of a SBO in children less than 3 years of age is valuable in its direction of the investigator's attention toward the possibility of a perforated appendix.

Additional imaging techniques, including contrast enemas [1, 4], US [4, 6, 13], localized tomography [8], and radio-labelled leukocyte scans [10, 14] have been suggested in other studies. Several studies place the sensitivity and specificity of US at over 90% [4], suggesting that it may be a valuable tool in the diagnosis of appendicitis; in our experience, it is very operator-dependent. Focused appendiceal tomography has reported positive and negative predictive values of over

85% and 99%, respectively [8, 2] in the adult population, although its cost-effectiveness and utility in the pediatric population remain to be seen. The significance of other laboratory tests, including C-reactive and acute-phase proteins, is primarily limited to research interests at this time [4] and plays little role in the diagnosis of pediatric appendicitis.

Reducing the morbidity in this population depends principally on increasing the rate of diagnosis at first presentation, since perforation of the appendix is usually associated with delays of greater than 36 h [11]. While abdominal pain, tenderness, and vomiting remain the hallmarks of diagnosis, these more specific symptoms and signs of appendicitis may be overshadowed by vague symptoms of irritability, fever, and diarrhea. It is clear that the value of such discussions and analyses is not only in the generalizations we draw from them, but also in the identification of particular symptoms or signs in this often misdiagnosed age group that can be used to increase our index of suspicion for acute appendicitis in children less than 3 years of age.

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## References

- Davenport M (1996) Acute abdominal pain in children. *BMJ* 312:498-501
- Lawrence RA (1999) Index of suspicion, Case 1. *Pediatr Rev* 20:137-138
- Irish MS, Pearl RH, Caty MG, et al (1998) The approach to common abdominal diagnosis in infants and children. *Pediatr Clin North Am* 45:729-772
- Horwitz JR, Gursoy M, Jaksic T, et al (1997) Importance of diarrhea as a presenting symptom of appendicitis in very young children. *Am J Surg* 173:80-82
- Singer JI, Losek JD (1992) Grunting respirations: chest or abdominal pathology? *Pediatr Emerg Care* 8:354-358
- Reynolds SL (1993) Missed appendicitis in a pediatric emergency department. *Pediatr Emerg Care* 9:1-3
- Swischuk LE (1999) Abdominal pain, vomiting and diarrhea. *Pediatr Emerg Care* 15:70-73
- Mollit DL, Mitchum D, Tepas JJD (1988) Pediatric appendicitis: efficacy of laboratory and radiologic evaluation. *South Med J* 81:1477-1479
- Lessin MS, Chan M, Catalozzi M, et al (1999) Selective use of ultrasonography for acute appendicitis in children. *Am J Surg* 177:193-196
- Vermeulen B, Morabia A, Unger P, et al (1999) Acute appendicitis: influence of early pain relief on the accuracy of clinical and US findings in the decision to operate - a randomized trial. *Radiology* 210:639-643
- Rao PM, Rhea JT, Novelline RA, et al (1997) Helical CT technique for the diagnosis of appendicitis: prospective evaluation of a focused appendix CT examination. *Radiology* 202:139-144
- Wong DW, Vainrapee P, Splenth ME, et al (1997) Rapid detection of acute appendicitis with Tc-99m-labeled intact polyvalent human immune globulin. *J Am Coll Surg* 185:534-543
- Rypins EB, Kipper SL (1997) 99m Tc-hexamethylpropyleneamine oxime (Tc-WBC) scan for diagnosing acute appendicitis in children. *Am Surg* 63:878-881
- Funaki B, Grosskreutz SR, Funaki CN (1998) Using unenhanced helical CT with enteric contrast material for suspected appendicitis in patients treated at a community hospital. *AJR*. 171:997-1001