Ir J Med Sci (2011) 180:55–58
DOI 10.1007/s11845-010-0526-y

ORIGINAL ARTICLE

Negative appendectomy experience in children

R. Karabulut · K. Sonmez · Z. Turkyilmaz · B. Demirogullari · I. O. Ozen · A. Demirtola · A. C. Basaklar · N. Kale

Received: 23 March 2007 / Accepted: 7 July 2010 / Published online: 25 July 2010

Abstract
Background The aim of this study was to discuss the findings of our patients who had negative appendectomy.
Patients and methods Hospital records of negative appendectomy for abdominal pain patients were evaluated retrospectively.
Results Negative exploration for acute appendicitis (AP) was done in 149 patients. The most frequent complaints were abdominal pain, vomiting and fever. The commonly established diagnoses after negative exploration were gastroenteritis and urinary infections. However, the frequent pathologies observed during the operation were mesenteric lymphadenitis and Meckel's diverticulum. All patients with systemic disease such as Henoch-Schonlein's purpura operated for AP had it diagnosed during the postoperative course. Interestingly, two different types of worms were found in the lumen of the appendices.
Conclusion Despite new techniques, 100% correct diagnosis of AP is still a challenging problem. Furthermore, appendicitis is a deadly disease if not treated properly. Therefore, it is best to perform exploration without undue delay in cases with suspicious AP.

Keywords Negative appendectomies · Abdominal pain · Acute appendicitis · Children

R. Karabulut (✉) · K. Sonmez · Z. Turkyilmaz · B. Demirogullari · I. O. Ozen · A. Demirtola · A. C. Basaklar · N. Kale
Department of Pediatric Surgery, Gazi University Medical Faculty, Gezegen Sokak 1/10, Gaziosmanpaşa, Çankaya, 06670 Ankara, Turkey
e-mail: karabulutr@yahoo.com

Introduction

Acute appendicitis (AP) is the most common surgical emergency in children and adolescents [1]. Diagnosis of appendicitis in children can be difficult and challenging. Over 70,000 pediatric appendectomies are performed annually in the USA; as many as 24% are negative appendectomies [2]. This difficulty is underscored by the fact that misdiagnosed cases of pediatric appendicitis are associated with corresponding increased rates of perforation, abscess formation, wound infections and death [3]. Despite the development of radiological techniques, a perfect diagnostic test for appendicitis does not exist yet. In an attempt to improve diagnosis, attention has been directed to radiological imaging and laparoscopy.

Here, we aimed to discuss the findings of our patients who underwent negative exploration for misdiagnosed AP.

Patients and methods

The hospital records of patients who underwent appendectomy for AP from January 1985 to December 2004 were retrospectively evaluated. The macroscopic and histopathologic data of patients who had negative exploration for abdominal pain were included in this study. Data obtained from the files included patients' history, laboratory, radiological and operative findings, and postoperative course.

Results

Between January 1985 and December 2004, 1,350 children were subjected to surgery for the diagnosis of AP. A total

of 149 (11%) of these patients were found to have no or pathology other than AP. The female to male ratio of these patients was 68/81. The mean age of the patients was found to be 9.7 years (range 1–16 years). The mean delay between onset of symptoms and presentation to a physician was 1.4 days (range 1–7 days). Oral antibiotics had been prescribed for 32 (21%) of these children.

The presenting signs and symptoms are summarized in Tables 1 and 2. Routine rectal examinations were performed in all cases. A history of diarrhea was noted in 40 children. Stool cultures were negative. As much as 32 of the patients had respiratory findings indicating acute upper airway infections and 7 (4.5%) had a history of constipation.

Mean white blood cell counts (WBC) was found to be 11,100 cells/mm^3 (range 3,200–23,000). All the children had undergone abdominal radiological investigation prior to the operation. Apart from commonly encountered radiological findings such as lumbar scoliosis ($n = 15$, 10%) and small intestinal air–fluid levels ($n = 43$, 29%), calcified fecalith was noted in three case. Ultrasound findings for 36 patients were as follows: AP in 10 cases, no pathology in 16 cases, free water in abdomen in 8 cases and ovarian cyst in 2 cases.

The cases were subjected to surgical exploration for AP through a transverse, muscle sparing, and right lower quadrant incision. The cases that did not have acute appendicitis were explored for other pathologies and the intraoperative findings are classified in Table 3. The most frequently present pathology was 13 cases of Meckel's diverticulum (MD). MD-related complications in six of these cases were detected (3 volvulus, 2 intussusception, 1 MD perforation). MD was incidentally found in seven other cases and resected.

During the postoperative course, two patients were diagnosed with HUS, another two with FMF and one patient with HSP. One patient developed lower lobe pneumonia on the third postoperative day. The histopathological examination of specimens of two patients revealed *Ancylostoma duodenale* and *Enterobius vermicularis* worms without any other signs.

Table 1 Presenting symptoms of negative appendectomies

	Number (%)
Abdominal pain	122 (81)
Vomiting	115 (77)
Fever	58 (38)
Diarrhea	40 (27)
Anorexia	33 (22)

Table 2 Presenting physical findings of negative appendectomies

	Number (%)
Guarding	110 (73)
Tenderness in the right lower quadrant	65 (77)
Diffuse tenderness	49 (38)
Abdominal distension	32 (27)

Table 3 Positive intraoperative findings of negative appendectomies

	Number (%)
Mesenteric lymphadenitis	23 (15)
Ovarian cysts	4 (2.6)
Acute pancreatitis	1 (0.6)
Related complications of Meckel's diverticulum	13 (8.7)
Ovarian torsion	2 (1.3.7)
Mesocyst	1 (0.6)
Omental infarct	2 (1.3)
Tubo-ovarian abscess	1 (0.6)

Discussion

So far, no reliable diagnostic method has been developed to confirm or exclude the diagnosis of AP prior to operation [4]. Due to difficulties in communication and examination of children, diagnosis of appendicitis in children is generally considered to be more difficult than in adults [3, 5].

In a study of 37,109 children who underwent surgical exploration with the diagnosis of acute appendicitis, the negative exploration rate was found to be 8.4% (3,103 patients) [2]. This rate reached as high as 57% for children younger than 6 years old [3, 6]. Our negative exploration rate was 11%, which was consistent with that in literature.

The histopathological results of two specimens revealed *Ancylostoma duodenale* and *Enterobius vermicularis* in our series. Although these worms were present in the lumen of the appendix, pathologic examination of these patients did not show any criteria for appendicitis (for example, neutrophil leukocyte in the wall).

The calculated mean WBC counts for the patients who had negative exploration were found to be 11,100 cells/mm^3 in our study [7]. Therefore, one should be more meticulous while evaluating patients with low WBC counts.

The abdominal X-ray of the patients who had been operated on with the diagnosis of AP showed 52% scoliosis and 38% air–fluid levels in the small intestine [8]. The abdominal roentgenograms of our patients revealed small intestinal air–fluid levels in 29% of the cases as the most frequent pathologic sign, and the lumbar scoliosis rate was

found in 10% of the cases. We believe that this high number of cases with air–fluid levels is due to the number of patients with gastroenteritis in our series.

Gamal et al. [9] reported a 7% incidence of diarrhea in cases of nonperforated appendicitis that increased to 35% for perforated appendicitis. The reason for this high percentage is apparent as both disease processes cause abdominal pain, vomiting, and increase of temperature. In addition, the presence of diarrhea implies significant local peritoneal inflammation.

Upper respiratory tract infections were also found to be the second most common cause of misdiagnosis (21%) in our study. Mesenteric adenitis is painful lymphadenopathy in the setting of pharyngitis or upper respiratory infection, and it can almost perfectly mimic appendicitis [1]. In the literature, mesenteric adenitis was shown to be the cause of negative explorations in 2–18% of patients [1, 3].

Although constipation can produce abdominal pain, vomiting and fever, it is a common coincidental finding and its presence does not rule out appendicitis [10]. The other conditions misdiagnosed as acute appendicitis in this study are MD (obstruction, perforation), ovarian cysts, ovarian torsion, mesocyst, acute pancreatitis, tubo-ovarian abscess and omental infarction. The treatment of choice in patients with symptomatic MD is surgery, while there are differences of opinion in the treatment of asymptomatic MD. Diverticulectomy is advocated in patients with a history of previous abdominal complaints. Factors necessitating surgical resection are cited as: a palpable mass within the diverticulum, a fibrous connection to the umbilicus that predisposes to volvulus and obstruction, presence of a vitelline vessel lacking a mesentery predisposing to incarceration and narrow diverticular neck predisposing to inflammation and obstruction [11, 12]. Noncomplicated MD, detected incidentally during the operation, was removed to avoid further problems later in life, because resection of incidentally found MD does not increase operative morbidity and mortality as found in a large study [13].

Patients with systemic disease such as Henoch-Schonlein's purpura (HSP), familial Mediterranean fever (FMF) and hemolytic uremic syndrome (HUS) underwent exploration for the suspected diagnosis of acute appendicitis. During the postoperative follow-up period, the patients were diagnosed accurately and treated accordingly.

To reduce the rate of negative exploration, various sophisticated diagnostic techniques were utilized. Recently, ultrasound was proven to be effective in the diagnosis of acute AP [14]. The reported sensitivity and specificity rates for ultrasound are 75–89 and 95–100%, respectively. Negative appendectomy rate in the whole series was 10.6% [14].

Laparoscopy is a limited technique for accurate diagnosis of acute appendicitis because it is invasive and also requires anesthesia. It is recommended that laparoscopy be performed only in patients who had a previous operation or retrocecal appendicitis [14]. In fact, in literature, the misdiagnosis rate of laparoscopic appendectomy has been reported to be higher than conventional appendectomy (19.6 vs. 15.5%, respectively; $p < 0.001$) [15].

Recently, computed tomography (CT) has proven to be more effective in the diagnosis of acute AP. The reported sensitivity and specificity rates are 87.2–99 and 16–98%, respectively [1]. The negative exploration rate was reported to be 5.5% in patients who had abdominal CT for abdominal pain [16]. Although CT is more accurate in diagnosing acute appendicitis, children are ten times more sensitive to radiation-induced cancer than adults. Hall estimated the risk for development of fatal cancer in a child who had an abdominal helical CT in childhood to be 1 in 1,000 [1, 17].

In conclusion, patients with abdominal pain should be evaluated carefully first by physical examination and with additional laboratory and radiological tests. If the suspicion of acute appendicitis persists, the patient in question should be admitted to clinic to follow up the case for a certain period. It is best to explore the abdomen of the patient who remains undiagnosed after the follow-up period. Considering the cost, risk and the detrimental effect of the complication of perforated appendicitis, it is best to perform operation without undue delay in spite of the aftereffect of negative exploration.

References

1. Kosloske AM, Love CL, Rohrer JE, Goldthorn JF, Lacey SR (2004) The diagnosis of appendicitis in children: outcomes of a strategy based on pediatric surgical evaluation. Pediatrics 113:29–34
2. Smink DS, Finkelstein JA, Kleinman K, Fishman SJ (2004) The effect of hospital volume of pediatric appendectomies on the misdiagnosis of appendicitis in children. Pediatrics 113:18–23
3. Rothrock SG, Skeoch G, Rush JJ, Johnson NE (1991) Clinical features of misdiagnosed appendicitis in children. Ann Emerg Med 20:45–50
4. Izbicki JR, Knoefel WT, Wilker DK et al (1992) Accurate diagnosis of acute appendicitis: a retrospective and prospective analysis of 686 patients. Eur J Surg 158:227–231
5. Horwitz JR, Gursoy M, Jaksic T, Lally KP (1997) Importance of diarrhea as a presenting symptom of appendicitis in very young children. Am J Surg 173:80–82
6. Graham JM, Pokorny WJ, Harberg FJ (1980) Acute appendicitis in preschool age children. Am J Surg 139:247–250
7. Turkyilmaz Z, Sonmez K, Demirogullari B et al (2000) Diagnostic value of laboratory tests in cases of suspected appendicitis: a prospective clinical study. J Turkish Assoc Pediatr Surg 14:107–110

8. Turkyilmaz Z, Sonmez K, Konus O et al (2001) Conventional X-ray findings in acute appendicitis. J Turkish Assoc Pediatr Surg 15:15–19
9. Gamal R, Moore TC (1990) Appendicitis in children aged 13 years and younger. Am J Surg 159:589–592
10. Mattei PA, Stevenson RJ, Ziegler MM (1999) Appendicitis. In: Wyllie R, Hyams SJ (eds) Pediatric gastrointestinal disease; pathophysiology, diagnosis, management, 2nd edn. WB Saunders Company, Philadelphia, pp 466–471
11. Neidlenger NA, Madan AK, Wrigth MJ (2001) Meckel's diverticulum causing cecal volvulus. Am Surg 67:41–43
12. DiGiacomo C, Cottone F (1993) Surgical treatment of Meckel's diverticulum. South Med J 86:671–675
13. Bani-Hani KE, Shatnawi NJ (2004) Meckel's diverticulum: comparison of incidental and symptomatic cases. World J Surg 28:917–920
14. Kang WM, Lee CH, Chou YH et al (1989) A clinical evaluation of ultrasonography in the diagnosis of acute appendicitis. Surgery 105:154–159
15. Flum DR, Morris A, Koepsell T, Dellinger EP (2001) Has misdiagnosis of appendicitis decreased over time? A population-based analysis. JAMA 286:1748–1753
16. Smink DS, Finkelstein JA, Garcia Pena BM, Shannon MW, Taylor GA, Fishman SJ (2004) Diagnosis of acute appendicitis in children using a clinical practice guideline. J Pediatr Surg 39:458–463
17. Hall EJ (2002) Lessons we have learned from our children: cancer risks from diagnostic radiology. Pediatr Radiol 32:700–706