Original Article

Iran J Pediatr
Dec 2011; Vol 21 (No 4), Pp: 485-490

Pathologic Evaluation of Appendectomy Specimens in Children: Is Routine Histopatholgic Examination Indicated?

Maryam Monajemzadeh[1,2], MD; Mohammad-Taghi Hagghi-Ashtiani*[1,2], MD; Laleh Montaser-Kouhsari[1], MD; Hamed Ahmadi[1], MD, Heidar Zargoosh[1], MD; Mehdi Kalantari[2,3], MD

1. Department of Pathology, Tehran University of Medical Sciences, Tehran, Iran
2. Children's Medical Center, Pediatric Center of Excellence, Tehran, Iran
3. Department of Surgery, Tehran University of Medical Sciences, Tehran, Iran

Received: *Jul 70, 2010*; Final Revision: *Dec 13, 2010*; Accepted: *Jan 15, 2011*

Abstract

Objective: Acute appendicitis is the most common cause of abdominal surgery in children. Similarity between signs and symptoms of appendicitis and other common pediatric illnesses, atypical manifestations of appendicitis in young children, and children's inability to give precise explanation for their symptoms contribute to considerable delay in proper diagnosis and increased rate of perforation. Current study reports the surgical and pathological findings of appendectomies in the largest Children's Hospital in Iran. It also evaluates whether common protocol for pathologic evaluation following appendectomy is beneficial.

Methods: Pathologic reports of 947 appendectomies, performed with the presumptive diagnosis of acute appendicitis, were gathered. Correlation between surgical and pathologic findings was assessed. Demographic characteristics of patients between surgical and pathological subgroups were also compared.

Findings: The mean age of participants was 6.9±3.5 years. Eighty seven (25.5%) children had abnormal pathological findings and normal surgical report. None of miscellaneous findings including appendicular carcinoid tumor 3 (0.3%), oxyuriasis 2 (0.2%), and mycobacterial infection 4 (0.5%) were recognizable during the surgery. Of all pathologically confirmed cases with perforated appendicitis, 9.7% were not detected during the surgery.

Conclusion: In current study, acute appendicitis was the most common pathological diagnosis, however, high normal appendectomy rate along with noticeable proportion of surgically missed perforated appendicitis and unusual histopathologies strongly supported routine histological examination.

Iranian Journal of Pediatrics, Volume 21(Number 4), December 2011, Pages: 485-490

Key Words: Acute Appendicitis; Appendectomy; Pathological Examination; Histopathology

*** Corresponding Author;**
Address: [illegible]
E-mail: [illegible]

Introduction

Acute appendicitis, the most common cause of abdominal surgery in children, has an incidence of 70,000 pediatric cases per year in the United States[1]. Similarity between signs and symptoms of appendicitis and other common pediatric illnesses such as acute gastroenteritis, atypical manifestations of appendicitis in young children, and children's inability to give precise explanation for their symptoms contribute to considerable delay in proper diagnosis and increased rate of perforation[2-4]. In fact, complicated appendicitis occurs in 75% of young children in some centers[5]. In addition, the rate of normal appendectomy comprises as high as 20% of all appendectomies in this group of patients[6-8]. Accordingly, the need for complementary evaluations in pediatric patients in order to confirm the initial diagnosis and to detect the complicated cases of appendicitis seems unavoidable.

Submission of specimens from various routine surgeries including tonsillectomy, varicectomy and hernia sacs for pathologic examination should be omitted[9], however, there are no similar recommendations for appendectomy specimens. In spite of concerns about the cost effectiveness[10], pathological examination may reveal additional pathologies such as appendiceal tumors and inflammatory bowel diseases that may not be evident during surgery but may affect subsequent clinical management[11].

Current study evaluated surgical and pathological findings of appendectomies in the largest Children's Hospital in Iran. It also aimed at determining whether common protocol of our center for routine pathological evaluation of appendectomy specimens is rational.

Subjects and Methods

Records of 947 patients who underwent appendectomy at Pediatric Center of Excellence, Tehran, Iran between 1988 and 2009 due to a presumptive diagnosis of acute appendicitis were evaluated. All appendices had been removed by open surgery and were routinely submitted for histological evaluation. Sections were taken from the base, body and tip of appendix and were immediately fixed with formalin prior to transfer to the pathologic laboratory. Demographic information and initial presenting complaint of patients were gathered. Intra-operative and microscopic reports of appendectomies were categorized into different subgroups and patients' characteristics were compared between these subgroups. Characteristics of cases with and without perforated appendicitis were also compared. Institutional Review Board of Tehran University of Medical Sciences approved the study.

The results were analyzed using SPSS, version 14. A *P*-value less than 0.05 was considered statistically significant. Results are expressed as mean (standard deviation).

Findings

The mean age of participants was 6.9(±3.5) years (range, 10 months to 15 years). Of all patients, 637 (67.3%) patients were males who had no significant age difference with females (6.8±3.6 and 7.1±3.3 years); (*P*=0.2). The most common clinical presentation was abdominal pain in 918 (96.9%) individuals and other reported presentations were rectal bleeding 20 (2.1%), abdominal distention 4 (0.4%), constipation 4 (0.4%), and prolonged icterus 1 (0.1%).

Surgical findings were abnormal in 607 cases (64.1%) including inflamed appendix 431 (71%), perforated appendicitis 84 (13.8%), gangrenous appendicitis 77 (12.6%), and periappendicular abscess 15 (2.4%). In other 340 cases (35.9%) no appendiceal abnormalities were found during surgery; nevertheless in 152 cases (16%), non-appendicular pathologies that mimicked acute appendicitis were established (Table 1).

Grossly the most common lesion found was congestion accompanied by dull serosa which were signs of acute inflammation related to appendicitis microscopically (*P*=0.0004). Histopathological findings were abnormal in 783 (82.7%) including acute appendicitis 205 (26.1%), acute suppurative appendicitis 381 (48.6%), gangrenous appendicitis 82 (10.4%), perforated appendicitis 93 (11.8%), chronic appendicitis

Table1: Intraabdominal pathologies mimicking acute appendicitis

Diagnosis	Number (% of all records)
Invagination	81(8.6)
Meckel's diverticulum	22(2.3)
Incarcerated hernia	16(1.7)
Malrotation	8(0.8)
Hirschsprung's disease	6(0.6)
Congestion	4(0.4)
Others	15 (1.7)

(defined as fibrous obliteration of appendix with recurrent attacks of abdominal pain suggesting appendicitis clinically) 7 (0.8%), periappendicitis 6 (0.7%), miscellaneous findings 9 (1.1%): oxyuriasis 2 (0.2%), appendicular carcinoid tumor 3 (0.3%), and mycobacterial infection shown by Ziehl-Neelsen staining 4 (0.5%).

All children with miscellaneous findings were clinically asymptomathic. Two cases of parasitic infection received antihelmithic treatment. Of three carcinoid tumors, one being microscopic was completely resected, two of them were larger than two cm with focal invasion to the mesoappendix so that right hemicolectomy was performed. Patients with presence of mycobacterium had primary immune deficiency and died.

Patients with pathologically normal appendices were significantly younger than those with simple acute appendicitis 4.7ڿ3.7 years and 8ڿ2.8 years (P<0.001), acute suppurative appendicitis 4.7ڿ3.7 years and 8.1ڿ2.8 years (P<0.001), and acute gangrenous appendicitis (4.7ڿ3.7 years and 7.3ڿ3.2 years P<0.001). There was no statistically considerable difference in terms of gender and initial presentation between different pathological subgroups. Table 2 summarizes the distribution of pathological subgroups in each surgical category. Accordingly, 87 (25.5%) of appendices which seemed apparently normal during the surgery found to be pathologically abnormal (total false negative appendectomy). Evidences of inflammation, perforation and periappendicular abscess were mostly compatible with the diagnosis of acute supporative appendicitis. Surgical evaluation had the highest accuracy for the diagnosis of acute gangrenous appendicitis. None of miscellaneous findings on pathology were correctly diagnosed at the time of surgery. As demonstrated in Table 3, there was no intra-operative report of perforation in case of non-perforated appendicitis while surgical assessment failed to recognize perforation in 10 (9.7%) patients with perforated appendicitis. There was no significant difference between these two groups in terms of age and gender.

Discussion

Current study presents the surgical and pathological statistics of appendectomies performed with the suspicion of acute appendicitis in 21 consecutive years in the largest Children's Hospital in Iran. Acute appendicitis is the most common cause of acute abdomen in children and appendectomy is considered as one of the most common surgeries worldwide [12]. True incidence of appendicitis however, may be overrated based on hospital discharge records without histo-pathological evaluation [13]. Timely intervention for acute appendicitis reduces the rate of

Table2: Distribution of various pathological subgroups according to intra-operative gross evaluation

Surgical findings	Pathologic findings						
	Normal	SAA	ASup.A	AGA	CA	PA	Other
Normal	160(47.1)	63(18.5)	7(2)	1(0.2)	6(1.8)	4(1.2)	6(1.8)
Inflammation	-	140(32.3)	282(64.7)	3(0.7)	1(0.2)	2(0.4)	3(0.7)
Perforation	-	2(2.3)	80(95.4)	2(2.3)	-	-	-
Gangrene	-	-	1(1.2)	76(98.2)	-	-	-
Periappendicular abscess	-	-	11(100)	-	-	-	-

AGA, acute gangrenous appendicitis; ASup.A, acute supporative appendicitis; CA, chronic appendicitis, PA, periappendicular abscess; SAA, simple acute appendicitis

Table 3: Characteristics of patients with pathological diagnosis of appendicitis with and without perforation

		With perforation (n=93)	without perforation (n=854)	P value
Age (year)		7.5 (2.9)	6.9 (3.6)	0.07
Male gender [Number (%)]		65 (69.9)	572 (67)	0.5
Surgical findings	**Perforation**	83 (90.3)	_	<0.001*
	Inflammation	2 (2.2)	444 (52)	
	Gangrene	7 (6.5)	71 (8.3)	
	Normal	1 (1)	339 (39.7)	

perforation in children and its possible consequences such as intra-abdominal adhesions or later, infertility. Therefore, surgeons consider normal appendectomies in up to 15% of all appendectomies acceptable [14]. However, the rate of misdiagnosis in some patients may be much higher [15-17]. For one thing, the accurate diagnosis is difficult to be made in children with atypical presentations and unreliable physical findings [18,19]. In spite of some recent derogatory comments [20,21], advanced diagnostic utilities such as computed tomography with rectal contrast and laparoscopy have dramatically increased the diagnostic accuracy in children. Accordingly, acceptable rate of negative appendectomy in children has been reduced to up to 18% [22].

Age and gender considerably affect the rate of false negative appendectomy. Agafonoff et al reported significantly higher rate of false negative appendectomies in children [23]. In a study by Primatesta et al female to male ratio for false negative appendectomies was found to be 1.8:1 with a peak at age 15-19 years [24]. Another study reported the highest false positive appendectomy rate in children younger than 9 years old [13]. Likewise, albeit no difference was found in terms of gender; children with false negative appendectomy were significantly younger in current study.

Perforation rate in pediatrics has been reported between 18-72% [25]. In current study, the rate of perforation, 9.8%, is notably low. As Gofrit et al suggested [25], this low rate could be relevant to a trend toward the pathogenesis of appendicitis and not essentially to earlier or enhanced diagnosis of the children. Routine histopathological examination of removed appendices is still the matter of debate. As for the rarity of significant unexpected pathologies and the high costs of specimen processing, some authors consider routine pathological survey a non-cost-effective method which is only indicated for a grossly abnormal appendix [11,26,27]. Pathological examination after appendectomy follows two main goals: 1) It can confirm the diagnosis of appendicitis especially when it is not obvious at the time of surgery. It has been shown that apparently normal appendices may have evidence of an inflammatory condition at microscopic observation[11,28]. Similarly, we found that nearly a quarter of grossly normal appendices were pathologically abnormal. 2) It may reveal some other pathologic conditions that substantially influence the treatment strategy. For instance, less than half of appendiceal tumors are distinguishable during operation [11,29]. As Deans et al stated, abnormal pathologic results which need additional examination or treatment were missed intra-operatively in 10 out of 13 patients [30]. Moreover, other pathologies such as inflammatory bowel disease, parasitic infections, endometriosis, and mycobacterial infection may be retrieved from appendectomy specimens [28,31,32]. In current study, pathological examination revealed specific pathologies that need additional treatment in 1% of all appendectomies.

One of the most important limitations of our study is that we did not have the exact radiologic and paraclinic data of our patients, especially normal appendectomies.

Conclusion

In conclusion, among variety of pathologies which involve the appendix, acute appendicitis was the most common cause of appendectomy. High rates

of normal appendectomy and surgically missed perforated appendicitis as well as considerable rate of unusual histopathologies strongly supported the need for routine histological assessment in our center.

Acknowledgment

This study was the thesis of Dr Heidar Zargoosh and was approved by pathology Department Research Committee in Tehran University of Medical Sciences.

Conflict of Interest: None

References

1. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol* 1990 Nov;132(5):910-25.
2. Rothrock SG, Skeoch G, Rush JJ, Johnson NE. Clinical features of misdiagnosed appendicitis in children. *Ann Emerg Med* 1991;20(1):45-50.
3. Horwitz JR, Custer MD, May BH, et al. Should laparoscopic appendectomy be avoided for complicated appendicitis in children? *J Pediatr Surg* 1997;32(11):1601-3.
4. Colvin JM, Bachur R, Kharbanda A. The presentation of appendicitis in preadolescent children. *Pediatr Emerg Care* 2007;23(12):849-55.
5. Rappaport WD, Peterson M, Stanton C. Factors responsible for the high perforation rate seen in early childhood appendicitis. *Am Surg* 1989; 55(10):602-5.
6. Reynolds SL. Missed appendicitis in a pediatric emergency department. *Pediatr Emerg Care* 1993;9(1):1-3.
7. Rabah R. Pathology of the appendix in children: an institutional experience and review of the literature. *Pediatr Radiol* 2007;37(1):15-20.
8. Jones K, Pena AA, Dunn EL, et al. Are negative appendectomies still acceptable? *Am J Surg* 2004; 188(6):748-54.
9. Fitzgibbons P, Cleary K. CAP offers recommendations on selecting surgical specimens for examination. *CAP Today* 1996; 10(7):40.
10. Matthyssens LE, Ziol M, Barrat C, Champault GG. Routine surgical pathology in general surgery. *Br J Surg* 2006;93(3):362-8.
11. Jones AE, Phillips AW, Jarvis JR, Sargen K. The value of routine histopathological examination of appendicectomy specimens. *BMC Surg* 2007; 7:17.
12. Blomqvist P, Ljung H, Nyren O, Ekbom A. Appendectomy in Sweden 1989-1993 assessed by the Inpatient Registry. *J Clin Epidemiol* 1998; 51(10):859-65.
13. Noudeh YJ, Sadigh N, Ahmadnia AY. Epidemiologic features, seasonal variations and false positive rate of acute appendicitis in Shahr-e-Rey, Tehran. *Int J Surg* 2007;5(2):95-8.
14. Flum DR, Morris A, Koepsell T, Dellinger EP. Has misdiagnosis of appendicitis decreased over time? A population-based analysis. *JAMA* 2001; 286(14):1748-53.
15. Styrud J, Eriksson S, Segelman J, Granstrom L. Diagnostic accuracy in 2,351 patients undergoing appendicectomy for suspected acute appendicitis: A retrospective study 1986-1993. *Dig Surg* 1999;16(1):39-44.
16. Pittman-Waller VA, Myers JG, Stewart RM, et al. Appendicitis: why so complicated? Analysis of 5755 consecutive appendectomies. *Am Surg* 2000;66(6):548-54.
17. Borgstein PJ, Gordijn RV, Eijsbouts QA, Cuesta MA. Acute appendicitis--a clear-cut case in men, a guessing game in young women. A prospective study on the role of laparoscopy. *Surg Endosc* 1997;11(9):923-7.
18. Mueller BA, Daling JR, Moore DE, et al. Appendectomy and the risk of tubal infertility. *N Engl J Med* 1986;315(24):1506-8.
19. Ates M, Sevil S, Bulbul M. Routine use of laparoscopy in patients with clinically doubtful diagnosis of appendicitis. *J Laparoendosc Adv Surg Tech A* 2008;18(2):189-93.
20. Weyant MJ, Eachempati SR, Maluccio MA, et al. Interpretation of computed tomography does not correlate with laboratory or pathologic findings in surgically confirmed acute appendicitis. *Surgery* 2000;128(2):145-52.
21. Karakas SP, Guelfguat M, Leonidas JC, et al. Acute appendicitis in children: comparison of clinical diagnosis with ultrasound and CT imaging. *Pediatr Radiol* 2000;30(2):94-8.
22. Warner BW, Kulick RM, Stoops MM, et al. An evidence-based clinical pathway for acute appendicitis decreases hospital duration and cost. *J Pediatr Surg* 1998;33(9):1371-5.
23. Agafonoff S, Hawke I, Khadra M, et al. The influence of age and gender on normal appendicectomy rates. *Aust NZJ Surg* 1987; 57(11):843-6.

24. Primatesta P, Goldacre MJ. Appendicectomy for acute appendicitis and for other conditions: an epidemiological study. *Int J Epidemiol* 1994; 23(1):155-60.
25. Gofrit ON, Abu-Dalu K. Perforated appendicitis in the child: contemporary experience *Isr Med Assoc J* 2001;3(4):262-5.
26. Raab SS. The cost-effectiveness of routine histologic examination. *Am J Clin Pathol* 1998; 110(3):391-6.
27. Wolkomir AF, Barone JE, Moser RL. Selective microscopic examination of gallbladders, hernia sacs, and appendices. *Am Surg* 1991;57(5):289-92.
28. Nemeth L, Reen DJ, O'Briain DS, et al. Evidence of an inflammatory pathologic condition in "normal" appendices following emergency appendectomy. *Arch Pathol Lab Med* 2001; 125(6):759-64.
29. Connor SJ, Hanna GB, Frizelle FA. Appendiceal tumors: retrospective clinicopathologic analysis of appendiceal tumors from 7,970 appendectomies. *Dis Colon Rectum* 1998; 41(1):75-80.
30. Deans GT, Spence RA. Neoplastic lesions of the appendix. *Br J Surg* 1995; 82(3):299-306.
31. Toorenvliet B, Vellekoop A, Bakker R, et al. Clinical differentiation between acute appendicitis and acute mesenteric lymphadenitis in children. *Eur J Pediatr Surg* 2011;21(2):120-3.
32. Chang YJ, Chao HC, Kong MS, et al. Misdiagnosed acute appendicitis in children in the emergency department. *Chang Gung Med J* 2010;33(5):551-7.