



Research Article

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Evolution of Recent Updates Regarding Diagnosis and Management of Inflamed Appendix in Children

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ABSTRACT

Background: Acute appendicitis is the most common abdominal surgical emergency in adults as well as children. Due to the peculiar anatomy of the appendix in children and the unique characteristics of this age group, acute appendicitis frequently presents atypically, more frequently misdiagnosed, and thus should be differently approached. **Objective:** Our aim was discussing the unique features of the appendix and acute appendicitis in children, and how it's approached and managed. **Methods:** We searched Pubmed for acute appendicitis, children, anatomy, manifestation, diagnosis, and management. **Conclusion:** Acute appendicitis in the pediatric age group has several peculiarities when compared to adults. It frequently presents atypically, and therefore more commonly misdiagnosed. An algorithmic approach that integrates a clinical scoring system, such as the Pediatric Appendicitis Score and diagnostic studies should be followed. Moreover, when surgery is decided, the laparoscopic approach is the standard of treatment and should be always used unless contraindicated. In brief, acute appendicitis in children is not just a smaller appendix inflamed.

Key words: Pediatric Appendicitis, Diagnosis, Management.

INTRODUCTION

Appendicitis is one of the most common surgical causes of abdominal pain in the elderly [1], and the most common cause in adults and children [2, 3]. This has been reported by several researchers [4, 5]. In children, however, this condition has many peculiarities in its manifestations, diagnosis, and treatment. Some of these peculiarities are due to the special characteristics of this age group, and yet others are inexplicable. Surgical intervention is sought in cases of acute appendicitis; several studies have reported the superiority of laparoscopic appendectomy over the traditional open approach. Antibiotics are thought to be beneficial in uncomplicated

appendicitis. We discuss below important features of acute appendicitis in children, diagnostic evaluation in this age group, and approach to management.

METHODOLOGY

We searched PubMed for acute appendicitis, children, anatomy, manifestation, diagnosis, and management. In regards to the inclusion criteria, the articles were selected based on the inclusion of one of the following topics; pediatric appendicitis, laparoscopic surgery versus open surgery, maintenance, and other non-operative modalities of treatment, in-hospital stay and pain control. Exclusion criteria were all other articles that did not have one of these topics as their primary endpoint.

DISCUSSION

Several differences in the anatomy of the appendix and omentum in young children compared to adults are of particular importance as they influence the epidemiology, presentation, and prognosis of acute appendicitis in young children. In general, the appendix achieves adult proportions by the age of 3 years [6]. The average appendiceal length is 4.5 cm in children and 9.5 cm in adults. Perhaps of more importance are the differences in the tip and base of the appendix. The appendiceal base of infants is funnel-shaped and wider in diameter compared to the cylindrical base seen in adults. Thus, they have less chance of luminal obstruction and subsequent inflammation. The appendiceal tip is more freely movable compared to the relatively fixed tip in adults. This difference, in addition to the underdeveloped omentum, explains why children are more likely to develop diffuse spillage of intestinal content into the peritoneum causing peritonitis if the appendix perforates compared to older children and adults who tend to develop a localized abscess [7]. Also, the mucosal lymphoid tissue and follicles hypertrophy throughout childhood and peak during adolescence when the incidence of acute appendicitis is highest [8].

One should keep in mind the conditions in which the appendix is not located in its usual place in the right lower quadrant of the abdomen, which leads to a diagnostic difficulty, especially in the emergency setting. Situs Inversus is one such condition in which the appendix, and essentially all other internal organs, is located on the opposite side. A review done in 2010 found 53 reported cases. Of them, 11 were in the pediatric age group [9]. Another less common condition is intestinal malrotation in which the appendix could be located in the right upper or left lower quadrants, and it occurs around 1 in every 500 live births [10]. In a review done in 2013, 32 cases of acute appendicitis in association with intestinal malrotation were reported in the English literature. Nine of them were in the pediatric age group [11]. Other such conditions include a long right-sided appendix with a tip located more to the left [12], and loosely attached cecum [13].

Clinically, acute appendicitis in children has the same general signs and symptoms as in adults. However, they differ in their occurrence rate, sensitivity, and specificity. The classic presentation includes anorexia, pain, vomiting, and fever. Appendicular pain starts as vague peri-umbilical pain and migrates over 24 hours to the right lower quadrant and becomes localized and aggravated by movement. On physical examination, the surgeon should notice signs of right lower quadrant tenderness, rebound tenderness, generalized peritonitis such as involuntary abdominal muscle contraction (aka abdominal guarding) with abdominal palpation, and signs of localized peritonitis (see *table 1*).

Table 1: The signs of localized peritonitis in acute appendicitis

Sign	Description
Rovsing	<ul style="list-style-type: none"> Pain in the right lower quadrant upon palpation of the left lower quadrant
Iliopsoas	<ul style="list-style-type: none"> Pain upon right hip extension Typically observed when a retrocecal appendix is inflamed, which is the most common location for the appendix in both adults and children.
Obturator	<ul style="list-style-type: none"> Pain upon right hip flexion and internal rotation Typically observed when a pelvic appendix is inflamed, which is the second most common location for the appendix.

Having said this, a prospective study published in 2007 included 755 children and adolescent patients with a median age of 11.9 years found several clinical peculiarities in the presentation of acute appendicitis in this age group. First, the typical sequence of events in acute appendicitis of peri-umbilical pain followed by nausea and migratory pain and later vomiting and fever is less frequent in children compared to adults. Also, children were found to more frequently present with sudden onset of pain (45%) compared to the more gradual onset classically observed. Also, several typical features of acute appendicitis were found frequently absent in the study's population [14]. These include absent fever (83%), absent Rovsing's sign (50%), absent guarding (47%), and absent anorexia (40%).

Several studies have been published that discussed the relative occurrence and variability of acute appendicitis manifestations in special pediatric age groups, such as neonates [15] and children between the age of 3 and 12 years old [16].

Back in 2002, a score named the Pediatric Appendicitis Score (PAS) was invented by analyzing the data of 1170 children aged between 4 and 15 years and suspected to have acute appendicitis [17]. The PAS has 8 variables, each given one point except for two given 2 points yielding a total score of 10 (see *table 2*).

Table 2: Pediatric Appendicitis Score (PAS)

Variable	Score
Cough/percussion/hopping tenderness in the right lower quadrant of the abdomen	2
Tenderness over the right iliac fossa	2
Anorexia	1
Fever	1
White blood cell count >10,000 cells/microL	1
Neutrophils plus band forms >7500 cells/microL	1
Nausea/ vomiting	1
Migration of pain	1

Although acute appendicitis, regardless of the patient's age, is classically diagnosed clinically on the grounds of the aforementioned clinical features and PAS, diagnostic studies, both laboratory, and imaging are frequently utilized to confirm the diagnosis or exclude differentials. This is particularly true in the case of children as they more frequently present with atypical features. This is evident from a prospective study done in 2015 to validate the Alvarado score and PAS for the diagnosis of acute appendicitis in children. The study concluded that both scores could aid in the diagnosis, but none has strong enough predictive values to be used alone in assessing and diagnosing acute appendicitis in children [18]. So, an algorithmic approach is useful to avoid any unnecessary diagnostic studies. Different approaches can be found. One such approach is the one concluded by a prospective cohort study published in 2018 [19]. The study included 288 children from an academic pediatric emergency department and classified them into three risk groups for appendicitis depending on their PAS. Low risk was if the score was less than 5, intermediate if less than 8, and high if between 8 and 10. They concluded that in the case of intermediate risk, clinical findings should be supplemented with radiological investigations, such as US or abdominal X-ray. In case of discordance, longer observation or further imaging is warranted.

We found that laparoscopic surgery was superior to open appendectomy in the pediatric age group. Liu Y *et al.* [20] found that major complications were significantly less in the laparoscopic approach than the open one. The children had lower pain after the laparoscopic appendectomy and better quality of life at one month relative to their peers who underwent an open appendectomy [20]. Pogorelic Z *et al.* [21] suggested the relative safety of the laparoscopic approach, with a 3-day hospital stay, reduced amount of analgesics, and lesser incidences of infections when compared to open appendectomy. The open approach had relatively higher infections, an increased mean hospital stay of 6 days, and increased analgesic requirements. However, re-operative frequency remained equal [21]. The overtly advantageous laparoscopic approach to appendicitis in children has been shown in multiple papers [20, 21]. Furthermore, it is the preferred procedure for children undergoing chemotherapy [22]. A retrospective study showed no significance of previous abdominal surgery on laparoscopic appendectomy; rendering the procedure safe in a previously operated patient [23]. However, Svensson JF *et al.* [24] reported no significant difference between the two surgical interventions with regard to complications and postoperative stay. Laparoscopy is currently the best operative approach in children with acute appendicitis.

An alternative to surgical intervention lies in the possibility of controlling appendicitis by medications. Georgiou R *et al.* [25] suggested that non-operative treatments had similar rates of complication and hospital stay to appendectomy. But this study was limited by the lack of prospective trials and recommended further evaluation of non-interventional modalities [25]. Other studies proposed antibiotics as the initial approach to uncomplicated appendicitis [26, 27]. Podda M *et al.* reported a significantly incremented efficacy and decremented complications with surgical appendectomy [28]. The higher failure rate was attributed to appendicolith, and therefore an appendectomy would be more appropriate than antibiotics alone [27]. The presence of vomiting and nausea should alert the surgeon towards the probability of a failed conservative treatment, and most importantly, the finding of an intraluminal fluid on ultrasound [29]. While conservative treatment is feasible and cost-effective in pediatric uncomplicated appendicitis, the surgeon should be ready-on for operative intervention.

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