Original Article

Appendicitis in Children: Does Age Really Matter?

Kamal El Haissoufi[1,2], El Hassan Hadi[1,2], Salaheddine Habib[1,2], Hanane Aissaoui[2,3], Mariam Atassi[2,3], Abdelouhab Ammor[1,2], Houssain Benhaddou[1,2]

[1]Department of Visceral and Urological Pediatric Surgery "A", Mohammed VI University Hospital, [2]Faculty of Medicine and Pharmacy, Mohammed 1st University, [3]Laboratory of Epidemiology, Clinical Research and Public Health, Faculty of Medicine and Pharmacy, Mohammed 1st University, Oujda, Morocco

Abstract

Background: Acute appendicitis (AA) is a frequent and emergent surgical abdominal condition that presents some particularities and challenges in young children. **Patients and Methods:** Data of 402 children aged <16 years with a confirmed diagnosis of AA were retrospectively reviewed. Included patients were divided into two groups: Group A (preschool children aged ≤5 years, $n = 44$) and Group B (school children aged >5 years, $n = 358$). Clinical presentation, biological findings, calculated diagnosis scores (paediatric appendicitis score [PAS] and Alvarado score), intraoperative findings and outcomes were comparatively analysed between the two groups. **Results:** Children of Group A had more likely fever, bowel disorders, diffuse abdominal pain and diffuse tenderness than those of Group B ($P = 0.001$, $P = 0.005$, $P = 0.006$ and $P = 0.001$, respectively). Regarding biomarkers, the mean of white blood cell count and C-reactive protein levels was higher in Group A than in Group B (18,849 cell/mm^3 and 162.8 mg/L in Group A versus 15,938 cell/mm^3 and 86.7 mg/L in Group B, $P = 0.003$ and < 0.001, respectively). The mean of calculated PAS and Alvarado scores was higher in Group A than in Group B (8.2 ± 1.1 and 8.2 ± 1 vs. 7.5 ± 1.4 and 7.4 ± 1.5, $P = 0.003$ and $P = 0.001$, respectively). Most children with a calculated PAS and Alvarado score equal to or higher than 8 belonged to Group A (PAS: 84.1% vs. 58.4%, $P = 0.001$, Alvarado score: 84.1% vs. 55.6%, $P < 0.001$). The perforation of the appendix was seen in 77.3% of Group A patients and only in 41.5% of children in Group B ($P < 0.0001$). The mean length of stay was 5.1 ± 1.9 days in Group A and 4.3 ± 2.8 days in Group B but without any statistical difference between the two groups ($P = 0.094$). **Conclusion:** AA in preschool children is associated with atypical presentation and rapid progression of the disease making the early diagnosis mostly challenging in our settings.

Keywords: Appendicitis, children, diagnosis, outcomes, preschool age

Introduction

Acute appendicitis (AA) is the most frequent abdominal disease that requires a fast diagnosis and an emergent surgical treatment to avoid possible mortality and morbidities.[1] Its annual incidence reached 100 cases per 100,000 persons and the highest frequency concerned patients with 10–19 years of age.[1,2] Its diagnosis remains generally evident in older children because of typical clinical symptoms at presentation.[3] However, appendicitis in young children is reported to be associated with a diagnosis delay and a rapid progression to appendicular perforation increasing the incidence of related complications.[4] This diagnosis delay could be explained by the atypical presentation of the young child and its limited communication and description abilities in front of the practician making the diagnosis mostly challenging.[5] Many researchers have recently treated the subject of AA amongst young and preschool children and insisted on its particularities in this group of age; nevertheless, up to date, only a few works were done to highlight these features in an African and developing country. Hence, the aim of our study was to compare the presentation and outcomes of appendicitis in preschool children to those in older children and to determine whether the younger age is really associated with some particularities.

Patients and Methods

Patients

A total of 402 children aged <16 years with a diagnosis of AA over a 7-year period between May 2015 and April 2022 in the

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Address for correspondence: Dr. Kamal El Haissoufi, Department of Visceral and Urological Pediatric Surgery "A", Mohammed VI University Hospital, 60000, Oujda, Morocco.
E-mail: kelhaissoufi@gmail.com

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Department of Pediatric Surgery of our academic institution, Mohammed VI University Hospital, were evaluated in this retrospective single-centred cohort study. We included in this work all children with <16 years of age, of both genders, treated with appendectomy because of AA, for whom the histopathologic analysis of the resected appendix was studied and available. Exclusion criteria were lack of data in medical documentation, patients aged more than 16 years or in whom another aetiology of abdominal pain with a normal appendix intraoperatively was considered. The included patients were divided into two groups based on their age: Group A including children aged 5 years or less (preschool children) and Group B of those older than 5 years.

Pre-operative, perioperative and post-operative data of enrolled patients were collected from their medical records. As pre-operative data, the following variables were studied: age, gender, onset of symptoms, symptoms at presentation and physical signs (e.g., fever, nausea, vomiting, diarrhoea, constipation, abdominal pain and tenderness) and biomarkers (white blood cell count [WBC] and C-reactive protein [CRP]). Intraoperatively, we focussed on the macroscopic appearance of the appendix and the presence of appendicular perforation. After surgery, length of stay (LOS) and possible complications whether during hospital stay or after hospital discharge were reported. A CRP value <6 mg/L and a WBC <10 × 10^3 cells/mm^3 were considered within the normal range.

Statistical analysis

A descriptive analysis was performed. Continuous variables were presented by averages with standard deviations, and qualitative variables were described using frequencies and percentages. Next, a univariate analysis was performed using the Chi-square or Fischer test to compare categorical variables and the Student's-*t*-test to compare quantitative variables. P <0.05 was considered statistically significant. All the statistical analysis was done using SPSS for Windows, version 21.0 (IBM, New York, USA).

Ethics statement

Before performing this study, an institutional approval from the ethics committee for biomedical research of our faculty of medicine was obtained.

Results

The mean age in our population was 9.6 ± 3.1 years. 63.2% of the included children were male and 36.8% were female. Importantly, the mean duration between the onset of symptoms and the arrival of children in the emergency department was 3.7 ± 4.7 and 4.2 ± 21.8 days for Groups A and B, respectively, and without a significantly statistical difference. However, fever which is considered present if the body temperature was 38°C or higher was more likely seen in Group A (P = 0.001). Furthermore, children of Group A presented bowel disorders (diarrhoea or constipation), diffuse abdominal pain and diffuse tenderness more frequently than those of Group B (P = 0.005, 0.006 and 0.001, respectively). On the other hand, no significance concerning nausea or vomiting was statistically demonstrated between the two groups.

In terms of biological findings, the mean of WBC and CRP levels was higher in Group A than in Group B: 18,849 cell/mm^3 and 162.8 mg/L in Group A versus 15,938 cell/mm^3 and 86.7 mg/L in Group B, respectively. A statistical difference was noticed concerning these both biological parameters between the two groups (P = 0.003 and < 0.001, respectively). Furthermore, WBC was abnormally elevated in 95.4% of Group A patients and in 85.2% of Group B children without any significant difference between the two groups. In addition, a CRP level within the normal range was only seen in 1 patient (2.3%) and in 17.3% of children of Group A and Group B, respectively, and that differed significantly between the two groups (P = 0.01). The demographics and physical and biological findings of both the groups are shown comparatively in Table 1.

Regarding calculated diagnosis scores, paediatric appendicitis score (PAS) and Alvarado score values were 8.2 ± 1.1 and 8.2 ± 1, respectively, in Group A higher than the corresponding scores of 7.5 ± 1.4 and 7.4 ± 1.5 in Group B (P = 0.003 and P = 0.001, respectively). Within all patients, only one did have a PAS of 2 and belonged to Group B. Otherwise, most preschool patients did have a PAS equal to or higher than 8 (84.1%) more than children of Group B (58.4%) (P = 0.001). Regarding Alvarado score, the minimum calculated total score at the presentation was 3 and only assessed in 6 children which belonged all to Group B. Similarly to PAS score, 84.1% of

Table 1: Demographics and preoperative physical and biological findings

	Group A (*n*=44)	Group B (*n*=358)	*P*
Sex			
Male	33 (75)	221 (61.7)	0.085
Female	11 (25)	137 (38.3)	
Onset of symptoms (days)	3.7±4.7	4.2±21.8	0.89
Fever	38 (86.4)	218 (60.9)	0.001
Nausea/vomiting	42 (95.5)	328 (91.6)	0.293
Diarrhoea/constipation	17 (38.6)	72 (20.1)	0.005
Abdominal pain			
Focal	23 (52.3)	259 (72.3)	0.006
Diffuse	21 (47.7)	99 (27.7)	
Tenderness			
Focal	14 (31.8)	208 (58.1)	0.001
Diffuse	30 (68.2)	150 (41.9)	
WBC			
Mean (cells/mm^3)	18,849±6521	15,938±5843	0.003
Normal count	2 (4.6)	53 (14.8)	0.062
CRP			
Mean (mg/L)	162.8±95.6	86.7±94.4	<0.001
Elevated	43 (97.7)	296 (82.7)	0.01

Values are presented as means±SD or as *n* (%). WBC: White blood cell count, CRP: C-reactive protein, SD: Standard deviation

Table 2: Paediatric appendicitis score and Alvarado scoring systems in both groups

Scores	Group A (*n*=44)	Group B (*n*=358)	*P*
PAS (total score)	8.2±1.1	7.5±1.4	0.003
Score interval			
2–7	7 (15.9)	149 (41.6)	0.001
≥8	37 (84.1)	209 (58.4)	
Alvarado (total score)	8.2±1	7.4±1.5	0.001
Score interval			
3–7	7 (15.9)	159 (44.4)	<0.001
≥8	37 (84.1)	199 (55.6)	

Values are presented as means±SD or as *n* (%). PAS: Paediatric appendicitis score, SD: Standard deviation

Table 3: Presence of appendicular perforation, length of stay and outcomes

	Group A (*n*=44)	Group B (*n*=358)	*P*
Appendicular perforation	34 (77.3)	148 (41.5)	<0.0001
Complications	6 (13.6)	15 (4.2)	0.11
SSI	1 (2.2)	7 (1.9)	
IAA	3 (6.8)	2 (0.5)	
Adhesive bowel obstruction	1 (2.2)	3 (0.8)	
Enterocutaneous fistula	0	1 (0.3)	
Mortality	1 (2.2)	2 (0.5)	
LOS: Mean (days)	5.1±1.9	4.3±2.8	0.094

Values are presented as means±SD or as *n* (%). SSI: Surgical site infection, IAA: Intra-abdominal abscess, LOS: Length of stay, SD: Standard deviation

children within Group A did have an Alvarado total score equal to or higher than 8 more frequently than those of Group B (55.6%) ($P < 0.001$) [Table 2].

Intraoperatively, the perforation of the appendix was seen in the majority of Group A patients (77.3%). However, this complication was only seen in 41.5% of children in Group B and that was statistically different between the two groups ($P < 0.0001$). After surgery, the following complications during hospital stay and after discharge were seen: surgical site infection in 8 (2%) patients, intra-abdominal abscess in 5 (1.2%) patients, adhesive bowel obstruction in 4 (1%) patients, enterocutaneous fistula in 1 (0.2%) case and mortality in 3 (0.7%) cases. In addition, the mean LOS in the hospital was 5.1 ± 1.9 and 4.3 ± 2.8 days for patients in Groups A and B, respectively, but that did not differ statistically between the two groups ($P = 0.094$). The intraoperative and post-operative findings of patients are shown comparatively in Table 3.

Discussion

Even though it was considered a frequent pathological condition in the paediatric population with an annual incidence of more than 10 cases per 100,000 persons aged <19 years, AA was described to be rarely seen in preschool children.[2,6] That reported rareness was consistent with patients' distribution in our population where preschool children represented only 10.9% of all includable cases. In addition, the atypical clinical presentation of preschool children was strongly related to a difficult initial diagnosis explaining the advanced stage of the disease within this group of patients.[7,8] Moreover, fever, bowel disorders, vomiting, diffuse abdominal pain and perforation of the appendix were more likely to be present in younger children.[8,9] Excluding vomiting as a revelation sign of the disease, all the previous features were preferably noticed in preschool children of our population. However, the main duration between the onset of symptoms and presentation was notably higher within the school-aged children group without any significance in our population. This correlation was inversely described by previously published results.[8,10] Indeed, this delay concerned mostly the majority of preschool children, and up to 17% of them presented at least after 6 days of the onset of initial symptoms.[11] Many authors explained the advanced stage of the disease at the diagnosis in younger children by this delay, but a rapid progression to the appendicular perforation was also demonstrated.[12] In fact, diffuse peritonitis as an evolution of no treated appendicular perforation is more frequently seen in younger children because of less developed omentum making the peritoneal cavity poorly protected.[5] Hence, younger children in our series were more and highly exposed to peritonitis despite the shorter interval from the onset of clinical signs to presentation, which can be explained by this rapid progression.

In terms of biological findings, WBC and CRP were commonly performed and have an important role in supporting the clinical diagnosis of AA in children as well as in differentiating patients with simple and perforated appendicitis.[13] Furthermore, WBC and CRP levels individually or taken together were reported to have a high specificity and sensitivity in predicting the perforation of the appendix in childhood, especially after 12 h of the onset of symptoms with a peak at 49 h or more.[13] Similarly, Pogorelić *et al*. found a significantly higher concentration of these biomarkers if the perforation was seen in children younger than 5 years of age.[9] Their levels were notably elevated in preschool children of our series which was consistent with the highly observed appendicular perforation in this group.

Concerning calculated diagnosis scores, Alvarado proposed in 1985 a diagnostic score bearing his name to elucidate the probability of having appendicitis regardless of the age of patients.[14] Thereafter, Samuel developed the PAS in 2002 to facilitate the diagnosis prediction of appendicitis in children but this score was established by including only children aged 4 years or above.[15] Hence, a threshold of 5 was fixed as a limit of compatibility with the diagnosis of appendicitis.[15] Moreover, children with PAS values ≤2 or Alvarado score values ≤3 were considered at a low risk of having appendicitis and those with score values ≥8 at a high likelihood of appendicitis.[12] In our patients, only one child did have a PAS value of 2 and six others with an Alvarado score value <3 which support the diagnosis

accuracy of these scores. In addition, more than half of school-aged children and the majority of younger ones did have a calculated score of 8 or above. Furthermore, in contrast with our results, it was reported that preschool children presented significantly lower values of these clinical scores than older patients.[12] This contrast can be related to the remarkable delay of initial presentation in our patients and the high rate of complicated appendicitis within preschool children.

The overall incidence of post-operative complications in our population reached 5.2% with a higher rate in preschool children (13.6%) but without any significant difference in comparison to school-aged children. Other authors considered this incidence to be rare in children and did not exceed 5%.[7,9,16] In addition, the median LOS in the hospital was 0.8 days longer in preschool children than in patients aged 6 years or above but without any significance (5.1 vs. 4.3 days; $P = 0.094$). That can be explained by the high incidence of perforated appendicitis within preschool children of our study population. Indeed, children with perforated appendicitis need a longer intrahospital recovery time than those without.[9] A more frequent intravenous administration of antibiotics in patients with complicated appendicitis is the rule which also can be related to late discharge.[9]

There are some limitations in this study. First, the low number of cases included in the preschool children group due to the rareness of the disease in younger children. Furthermore, it is a retrospective single-centre study led in an academic institution. Therefore, prospective multicentric studies including more patients in similar settings are recommended to validate and discuss critically our findings.

Conclusion

Diagnosis of AA in preschool children remains challenging because of the atypical presentation. The young age is also related to a high rate of complicated appendicitis. Therefore, the initial clinical evaluation by an experienced paediatric surgeon has a primordial role in avoiding misdiagnosis or any diagnosis delay.

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Conflicts of interest

There are no conflicts of interest.

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