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Original Article

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Different Clinical Features and Lower Scores in Clinical Scoring Systems for Appendicitis in Preschool Children: Comparison with School Age Onset

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Purpose: To clarify the clinical features of appendicitis in preschool children and to explore clinical appendicitis scoring systems in this age group.

Methods: We retrospectively collected data on 142 children, aged 10 years or younger, with confirmed diagnosis of appendicitis based on surgical and pathologic findings. Enrolled subjects were divided into two groups: Group 1 (preschool children aged ≤5 years, n=41) and Group 2 (school children aged >5 to ≤10 years, n=101). Data analyzed included clinical presentation, laboratory findings, the pediatric appendicitis score (PAS), and the modified Alvarado score (MAS).

Results: The most common presenting symptom was abdominal pain in both groups (92.7% vs. 97.0%). Other presenting symptoms were as follows: fever (65.9%), vomiting (68.3%), right lower quadrant (RLQ) localization (24.4%), anorexia (14.6%), and diarrhea (7.3%) in Group 1, and RLQ localization (74.3%), vomiting (71.3%), anorexia (52.5%), fever (47.5%), and diarrhea (11.9%) in Group 2. Perforation and abscess occurred more frequently in Group 1 than in Group 2 (43.9% vs. 12.9%, $p<0.001$; 34.1% vs. 5.0%, $p<0.001$; respectively). PAS and MAS were lower in Group 1 than in Group 2 (4.09±1.97 vs. 6.91±1.61, $p=0.048$; 4.65±1.79 vs. 6.51±1.39, $p=0.012$; respectively).

Conclusion: In preschool children, appendicitis often presents with atypical features, more rapid progression, and higher incidence of complications. This age group is more likely to have lower PAS and MAS than those of school children.

Key Words: Appendicitis, Child

INTRODUCTION

Acute appendicitis is the most common acute abdominal condition requiring emergent surgery in children. It is a pathologic continuum disease that begins with inflammation of the appendix and pro-

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gresses to perforation, through mural necrosis. Clinical presentation of appendicitis varies according to the pathologic progression of the disease [1-3].

Typical cases of acute appendicitis, which begin with visceral pain and then shift to a localized parietal pain in the right lower quadrant (RLQ), generally present in older children and diagnostic approach and intervention are performed promptly without delay in these cases. However, the timely diagnosis of acute appendicitis in preschool children remains problematic. The delayed diagnosis or misdiagnosis occur not uncommonly [4,5] because appendicitis in this age is an unusual event with atypical presentation and sometimes presents an overlap of symptoms with acute gastroenteritis or other common childhood illnesses. The poor describing and communicating abilities in younger aged children with abdominal examinations also presents a challenge to practitioners making suspicion of appendicitis. The appendicitis in preschool ages often show significant morbidities due to diagnostic delays and more rapid pathologic progressions associated with a higher incidence of perforation and related complications [6-9]. Hence, timely no delayed diagnosis in this age is important to reduce morbidities. In this regard, suspicion by clinicians who are particularly attentive to the symptoms of appendicitis is mandatory.

Clinical scorings as pediatric appendicitis score (PAS) and the modified Alvarado score (MAS) are used as tools to support clinical decision-making for acute appendicitis. These scoring systems consist of evaluation of anorexia, nausea/vomiting, symptoms of fever, RLQ tenderness, and white blood cell (WBC) count test results [10,11]. Even though they are not perfect scoring systems, PAS was more sensitive and accurate than abdominal ultrasound (US) and had almost the same specificity in 4- to 18-year-old children with appendicitis [12]. The MAS is useful for eliminating unnecessary use of computed tomography in aged 3 to 16 years with acute appendicitis [13]. These scores were validated in the studies for pediatric appendicitis including that of preschool and school aged children [10-13]. However, in preschool-aged children, the presentation of appendicitis is nonspecific or atypical and usually rapidly progresses in pathology. So, the clinical scores may be different from those of school-aged children. In the literature, there are no studies that have evaluated these clinical scores separately for children of preschool age.

We performed the present study to delineate the clinical features in preschool aged children and compare PAS and MAS scores in this age group and those of school-aged children.

MATERIALS AND METHODS

We retrospectively collected medical data from the cases of patients aged ≤10 years, who were diagnosed with appendicitis and had an appendectomy from March 2012 to July 2016 in the Chungnam National University Hospital. Acute appendicitis was confirmed based on surgical and pathological results. Patients who underwent incidental appendectomies for causes other than acute appendicitis, or who were diagnosed with acute appendicitis during hospitalization due to other diseases, or whose medical records were incomplete, were excluded from the study.

Patients were divided into two groups as follows: a preschool age group (Group 1: children aged ≤5 years old) and a school age group (Group 2: aged >5 to ≤10 years). The medical records were reviewed for age, sex, symptoms (abdominal pain, RLQ pain, anorexia, fever, nausea/vomiting, diarrhea, upper respiratory symptoms), physical examination (RLQ tenderness, diffuse tenderness, rebound tenderness, muscle guarding), blood test results (WBC counts, neutrophil counts, C-reactive protein [CRP] levels), surgical findings (perforation, abscess or phlegmon, appendicolith), interval between symptom onset and diagnosis, and duration of hospitalization. MAS and PAS were calculated and compared between the two groups. In Group 1, the medical histories of presenting symptoms were obtained from their caregivers.

Data were analyzed using IBM SPSS Statistics ver. 20.0 (IBM Co., Armonk, NY, USA). Comparison of

symptoms, physical examinations, and surgical findings between the two groups, and the patient distribution according to the PAS interval, was done by Fisher's exact test. Laboratory findings and clinical course were assessed by the Student's t-test. Statistical significance was set at $p<0.05$.

Ethics statement

This study was performed with approval from the Institutional Review Board of the Chungnam National University Research Council (IRB no. 2017-09-024). Informed consent was waived by the board.

RESULTS

There were 41 patients (22 males, 19 females) in the preschool-age group (Group 1) and 101 (62 males, 39 females) in the school-age group (Group 2). The mean age was 4.30 years (range, 2.0-5.9 years) in Group 1 and 8.95 years (range, 6.1-10.9 years) in Group 2.

In both groups, the most common symptom was abdominal pain (92.7% in Group 1; 97.0% in Group 2) (Table 1). There were three cases without abdominal pain in each group. The symptoms and findings of physical examinations are shown in Table 1. Fever was observed in all six cases. Tenderness was detected in all three cases of Group 2 and only in the second case of Group 1. In cases 1 and 3, acute appendicitis was diagnosed by abdominal US, performed during the process of evaluating fever (Table 2).

RLQ localizations, reflecting migration from visceral pain to peritoneal pain, were significantly lower in Group 1 (24.4%) than in Group 2 (74.3%) ($p<0.001$). Anorexia appeared in 14.6% of cases in Group 1 and in 52.5% of cases of Group 2 ($p<0.001$), but fever was more prevalent in the former (65.9% and 47.5% in Group 1 and Group 2, respectively; $p=0.036$). Nausea/vomiting, diarrhea, and symptoms of upper respiratory tract infection were comparable between the groups.

Abdominal tenderness was noted in 85.4% of cases in Group 1 and in 100% of cases of Group 2. The incidence of localized tenderness was lower in Group 1 than in Group 2, but that of diffuse tenderness was relatively higher in Group 1 (Table 1, $p<0.001$, $p=0.010$). Six cases (14.6%) without tenderness in Group 1 presented with vomiting and four cases had appendicolith. Rebound tenderness was observed in 22.0% of cases in Group 1 and in 37.6% of cases in Group 2, but this difference was not statistically significant. The perforation rate was 43.9% and 12.9% in Group 1 and 2, respectively ($p<0.001$). The incidence of abscess formation was higher in Group

Table 1. Comparison of Presenting Symptoms and Physical Examinations in both Groups

Clinical features	Overall (n=142)	Preschool age (n=41)	School age (n=101)	*p*-value*
Symptoms				
Abdominal pain	136 (95.8)	38 (92.7)	98 (97.0)	0.355
RLQ localization	85 (59.9)	10 (24.4)	75 (74.3)	<0.001
Nausea/vomiting	100 (70.4)	28 (68.3)	72 (71.3)	0.839
Fever	75 (52.8)	27 (65.9)	48 (47.5)	0.036
Anorexia	59 (41.5)	6 (14.6)	53 (52.5)	<0.001
Diarrhea	15 (10.6)	3 (7.3)	12 (11.9)	0.554
URI symptoms	16 (11.3)	6 (14.6)	10 (9.9)	0.398
Physical examinations				
Localized tenderness	120 (84.5)	25 (61.0)	95 (94.1)	<0.001
Diffuse tenderness	17 (12.0)	10 (24.4)	7 (6.9)	0.010
Rebound tenderness	47 (33.1)	9 (22.0)	38 (37.6)	0.080
Muscle guarding	8 (5.6)	4 (9.8)	4 (4.0)	0.228

Values are presented as number (%).
RLQ: right lower quadrant, URI: upper respiratory infection.
*Fisher's exact test.

Table 2. Symptoms and Signs in Children without Abdominal Pain

Clinical features	Anorexia	Nausea/ vomiting	Fever	Diarrhea	Localized tenderness	Diffuse tenderness	Rebound tenderness
Preschool age group (y)							
Case 1 (2.2)	−	−	+	−	−	−	−
Case 2 (4.3)	−	+	+	−	+	−	−
Case 3 (4.7)	+	−	+	−	−	−	−
School age group (y)							
Case 4 (6.5)	−	+	+	−	+	−	−
Case 5 (8.0)	+	+	+	−	−	+	−
Case 6 (10.8)	−	−	+	−	+	−	+

Table 3. Comparison of Laboratory Findings between both Groups

Clinical features	Preschool age (n=41)	School age (n=101)	*p*-value*
White blood cell (μ/mL)	15,023±5,781	15,704±4,687	0.157
Segmented neutrophil (μ/mL)	12,014±5,244	13,103±4,437	0.233
C-reactive protein (mg/dL)	8.08±7.22	3.13±2.84	<0.001

Values are presented as mean±standard deviation.
*t-test.

Table 4. Scoring Systems in both Groups

Clinical features	Preschool age (n=41)	School age (n=101)	*p*-value
Pediatric appendicitis score (total score)	4.09±1.97	6.91±1.61	0.048*
Score interval			
≤2	5 (12.2)	0 (0)	<0.001†
3 to 7	31 (75.6)	61 (60.4)	0.085†
≥8	5 (12.2)	40 (39.6)	0.001†
Modified Alvarado score (total score)	4.65±1.79	6.51±1.39	0.012*
Score interval			
≤3	10 (24.4)	4 (4.0)	<0.001†
4 to 6	24 (58.5)	39 (38.6)	0.030†
≥7	7 (17.1)	58 (57.4)	<0.001†

Values are presented as mean±standard deviation or number (%).
*t-test, †Fisher's exact test.

1 (34.1% in Group 1 and 5.0% in Group 2) ($p<0.001$). Appendicolith was observed in 53.7% and in 40.6% of cases in Groups 1 and 2, respectively, with no significant difference between them.

Table 5. Comparison of Surgical Findings and Clinical Course between both Groups

Clinical features	Preschool age (n=41)	School age (n=101)	*p*-value
Interval from onset of symptoms to diagnosis (h)	48.5±40.2	30.6±25.5	0.006*
Surgical findings			
Perforation	18 (43.9)	13 (12.9)	<0.001†
Abscess	14 (34.1)	5 (5.0)	<0.001†
Appendicolith	22 (53.7)	41 (40.6)	0.193†
Use of antibiotics (d)	9.29±3.34	7.86±2.90	0.326*
Hospital stay (d)	5.23±2.18	4.01±1.91	0.001*

Values are presented as mean±standard deviation or number (%).
*t-test, †Fisher's exact test.

In blood tests, the WBC count was 15,023±5,781 μ/mL in Group 1 and 15,704±4,687 μ/mL in Group 2. The segmented neutrophil counts were 12,014 ±5,244 and 13,103±4,437 μ/mL in Group 1 and 2, respectively. There was no difference between the two groups in either of these parameters. CRP was higher in Group 1 (8.08±7.22 mg/dL) than in Group 2 (3.13±2.84 mg/dL) (Table 3, $p<0.001$).

In Group 1, the incidence of perforation and abscess formation, frequency of fever, and CRP levels were higher and duration of hospitalization was longer. Though the severity of Group 1 was worse, PAS and MAS values were 4.09±1.97 and 4.65±1.79, respectively, lower than the corresponding scores of 6.91±1.61 and 6.51±1.39 in Group 2 (Table 4, $p=0.048$ and $p=0.012$, respectively). In the PAS analysis of by score, 12.2% of cases in Group 1 had scores of ≤2, suggesting a very low likelihood of ap-

pendicitis, and only 12.2% of cases scored ≥8, which is highly associated with appendicitis (Table 4). In contrast, in Group 2, there were no cases with scores ≤2. There was a significant difference between both groups regarding PAS of ≤2 or ≥8 (Table 4, $p<0.001$ and $p<0.001$, respectively). The proportion of cases with MAS of ≤3 was 24.4% vs. 4.0%, and that of MAS ≥7 was 17.1% versus 57.4%, in Groups 1 and 2, respectively. The analysis by each score of the MAS showed a larger gap than the PAS as score ≤3 is 24.4% vs. 4.0% and ≤7 is 17.1% vs. 57.4% (Table 4).

The time interval from symptom onset to diagnosis was significantly longer in Group 1 (48.5±40.2 hours) than in Group 2 (30.6±25.5 hours) ($p=0.006$). There was no difference in the duration of antibiotic use between both groups, but the hospital stay was longer in Group 1 (Table 5, $p=0.001$).

DISCUSSION

RLQ pain, nausea/vomiting, and decreased appetite are common presentation in acute appendicitis, but about 40% of patients do not present these typical symptoms [14]. Younger aged children with acute appendicitis may show nonspecific or atypical symptoms and insufficiently describe their presentation with poor cooperation on physical examination. Consequently, it is a challenge for the physician to makes a timely diagnosis of appendicitis in preschool children [7]. Sometimes appendicitis is misdiagnosed as another disease, and the diagnosis is delayed, resulting in morbidity and medical disputes.

Our study evaluated the clinical features of acute appendicitis in preschool children (aged ≤5 years). PAS and MAS indices, which have been proposed as adjunctive tools for diagnosis, were examined to evaluate their possible application in diagnosing acute appendicitis in preschool children, a condition characterized by tendency with atypical clinical features and rapid progressing pathology. The incidence of nonspecific symptoms, diffuse abdominal tenderness, perforation, and abscess formation was significantly higher in preschool-aged children than in the school-aged children. The preschool children had a higher severity of acute appendicitis, but lower PAS and MAS than the school-aged individuals. Furthermore, in the preschool age group, the proportion of cases with a PAS ≤2 (i.e., little possibility of acute appendicitis) was 12.2%, and only 12.2% had a PAS ≥8 (i.e., most probably had appendicitis). This data was different from the results of school-aged group, and the MAS also showed significant differences between the two groups.

Previously, Graham et al. [15] documented a low incidence of acute appendicitis in preschool-aged children, with less than 5% occurrence in children aged <5 years . In a study by Alloo et al. [5], the incidence of acute appendicitis in children aged ≤3 years was 27 cases in 20 years. In our study, 14 cases of acute appendicitis in subjects aged ≤3 years were diagnosed over a period of 4.3 years.

The most common symptom in this study was abdominal pain, which was observed in 92.7% of the children in Group 1 and 97.0% of those in Group 2. There were three cases without abdominal pain in each group, respectively. Of the three cases in Group 1, two had no tenderness or rebound tenderness, and appendicitis was diagnosed in the process to evaluate the cause for fever. In Malliac's study of patients aged ≤5 years, abdominal pain was present in 90.5% of the cases and absent in 10 cases [6]. In our study, symptoms other than abdominal pain were vomiting (68.3%), fever (65.9%), and anorexia (14.6%) in Group 1, and vomiting (71.3%), anorexia (52.5%), and fever (47.5%) in Group 2, respectively. Among these, only fever and anorexia were significant differences between the both groups. In a study of preschool-aged individuals by Sakellaris et al. [16], the incidence of nausea/vomiting (86%), fever (75%), and anorexia (40%) were slightly higher than those of Group 1 in our study.

RLQ localization, which is very important finding in acute appendicitis and refers to the progression from visceral pain to parietal pain, was significantly different between both groups, being 24.4% in Group 1 and 74.3% in Group 2. This data may represent a

true difference, but may also have been affected by the limitations of the expression of symptoms in preschool aged children. Diarrhea occurred in 7.3% and 11.9% of cases, respectively, in Groups 1 and 2, and although it was not high, alongside vomiting, it represents the most common cause of misdiagnosis as acute gastroenteritis. In our study, the initial diagnosis of acute appendicitis misdiagnosed as acute gastroenteritis occurred in 15% of Group 1 and in 4% of Group 2. The incidence of misdiagnosing acute gastroenteritis was the same as that of diarrhea in the preschool age cohort. In other studies, Sakellaris et al. [16] reported 46% of cases with diarrhea in preschool aged children, and in study by Alloo et al. [5], in children aged ≤3 years, the incidence of diarrhea was 41%. In our study, diarrhea occurred in 15% of preschool aged children and in 12.5% of children aged ≤3 years, respectively, which are lower than those reported by Sakellaris et al. [16] and Alloo et al. [5].

Findings of physical examination showed that localized tenderness was observed in 61.0% and diffuse tenderness occurred in 24.4% of cases in Group 1, with corresponding rates of 94.1% and 6.9% in Group 2, respectively. The frequency of diffuse tenderness was higher in the preschool-aged cohort, and this was because the disease generally progresses faster in this age group than school-aged group. In our study, diffuse peritonitis was observed in two of eight cases (25%) in those aged ≤3 years, compared to 37% in the study by Alloo et al. [5].

In children of preschool age, the incidence is not high and the main symptoms of acute appendicitis are nonspecific, such as abdominal pain, vomiting, and fever. Hence, other diseases like intussusception, acute gastroenteritis, and viral illnesses with mesenteric lymphadenitis, are often considered at first [7]. In this study, nine cases (8.9%) in the school age group and 15 cases (36.6%) in the preschool age group presented an initial diagnosis other than appendicitis. Furthermore, of the 41 cases in the preschool age group, 24 were transferred from a primary or secondary medical clinic to our emergency room (ER), and 12 (50.0%) of these cases were diagnosed as diseases other than appendicitis at initial diagnosis. On the other hand, among 17 cases that came directly to ER of Chungnam National University Hospital, only 3 cases (17.6%) were impressed as not having appendicitis initially. The initial resident's impressions of 3 cases were intussusception, acute pharyngitis, and neutropenic fever, respectively. In contrast, among initial diagnosis of 12 cases which were transferred from other hospitals, 6 cases with fever and vomiting or diarrhea were diagnosed as acute gastroenteritis; 3 cases which had abdominal pain intermittently as intussusception; 3 cases which symptoms were not clear and had fecal impaction in the abdomen x-ray as constipation. The reason for the difference in the initial diagnosis rate is that appendicitis is nonspecific in preschool-aged children and the diagnosis is difficult because of atypical clinical features on presentation. Physicians in the primary or secondary medical institutions usually care for mild disease with having quick evaluation time based on the history and physical examination. Therefore, it is a priority to decide whether to refer or follow up a child rather than determine an accurate diagnosis. On the other hand, in our ER, the diagnosis rate was high because there was sufficient taking of medical history, a complete basic physical examination, clinician awareness of various clinical manifestations of surgical abdomen including pediatric appendicitis, and smooth cooperative system with surgeons.

The duration from symptom onset to diagnosis was 15.5 hours longer in Group 1 than in Group 2, increasing the incidence of perforation, abscess, and phlegmon in the preschool-aged cohort, and ultimately resulting in a more prolonged hospitalization. The rates of perforation and abscess formation were 44% and 34% in Group 1, and 13% and 5% in Group 2, respectively. Previous studies have shown a 51% to 100% perforation rate in preschool children aged less than 5 years, which is higher than the 11% to 32% observed in school-aged children [8,16-18].

Pelvic/abdominal computed tomography is the most accurate and less operator-dependent tool for the diagnosis of pediatric appendicitis, but there are radiation hazards associated with the technique;

whereas, the sensitivity and specificity of US examinations differs depending on the examiner [12,19]. Sayed et al. [12] reported that PAS, a clinical scoring tool that reflects symptoms, laboratory findings, and blood test results, is useful in clinical decision-making processes when considering the necessity of imaging modalities for the diagnosis of acute appendicitis. In determining PAS, values ≤2 indicate that the likelihood of appendicitis is very low, while a PAS ≥8 suggests a high likelihood of appendicitis, and PAS 3-7 warrants further evaluation [10]. In MAS, a score of 0-3 points means acute appendicitis can be excluded, 4-6 points denotes acute appendicitis is more likely than any other disease, and 7-9 points are diagnostic [11]. However, the question is whether it is possible to apply the same scoring system to preschool-aged children, where presentation and the clinical course are rapidly progressing. In this study, PAS and MAS were 4.09±1.97 and 4.65±1.79 in Group 1, and these values were significantly lower than those in Group 2 (6.91±1.61 and 6.51±1.39, respectively). In Group 1, 12.2% had a PAS ≤2 with a very low possibility of appendicitis. Just 12.2% had a PAS of ≥8 which is very high. This result was significantly different from that of Group 2. According to the MAS, appendicitis could be excluded (MAS ≤ 3) for 24.4% of Group 1, and those with a diagnosable score (≥7) were only 17.1%. In comparison with the Group 2, MAS was less useful in Group 1. These results raise the question of whether or not the findings by Sayed et al. [12] in a group of 4- to 18-year-old subjects indicating PAS as a useful index for determining whether an imaging modality is needed for a diagnosis of appendicitis may be applied to preschool-aged children. The results of PAS and MAS in the preschool age group analyzed herein suggests that as atypical presentation is common, PAS and MAS indices may be underestimated because of limitations due to an accurate assessment of medical history and physical examination. Otherwise, it may mean that the score criteria should be lowered in this age group so future research is needed to better evaluate young preschool-aged patients.

The limitation of this study is that it is a retrospective study including only a few cases. In addition, negative appendectomy cases were not included, and the sensitivity, specificity, positive predictive value, and negative predictive value of PAS and MAS were not evaluated in the preschool age group. The authors are currently investigating these issues.

In conclusion, in preschool-aged children, acute appendicitis exhibited more nonspecific symptoms and rapid progression, while the incidence of complications was higher because the time from symptom onset to diagnosis was longer than in school-aged children. Also, compared to the school-aged children, the preschool age group had a higher incidence of more severe acute appendicitis, but with lower PAS and MAS values. Therefore, in preschool-aged children imaging surveillance such as US is necessary early in the differential diagnosis of appendicitis.

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