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Prevalence of appendicolith in children with acute appendicitis and its correlation with disease severity

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ABSTRACT

OBJECTIVE: Appendicitis typically develops secondary to obstruction of appendiceal lumen and one of the causes of obstruction is appendicolith. Appendicolith has become a relevant issue due to heightened interest in the treatment of uncomplicated appendicitis with antibiotics. This study aimed to determine the prevalence of appendicolith in pediatric patients with appendicitis and to investigate the association between the presence of appendicoliths and radiological disease severity.

METHODS: Patients under the age of 18 diagnosed with appendicitis between March 2021 and April 2022 and had available preoperative computed tomography (CT) images were identified retrospectively. The presence of an appendicolith and if present, its longest diameter in the axial plane, its visibility on direct radiographs, appendiceal diameter, degree of inflammation, and the presence of perforation were evaluated. Radiological severity of inflammation was rated on a 3-point scale.

RESULTS: CT scans were available in 77 (32.1%) of 240 patients with histopathologically confirmed diagnosis of acute appendicitis. 39% (n=30) of the patients were girls and the median age was 13 years. The prevalence of appendicoliths detected on CT scans was 32.5% (n=25) and the median size of appendicoliths was 6 mm. In only 1 patient, appendicolith was detected by direct radiography. The median appendiceal diameter was significantly greater in the group with appendicoliths (10 mm vs. 8 mm; p=0.001). A moderate correlation was found between appendicolith size and appendiceal diameter (r=0.407, p=0.043). Perforation was present in 10.4% (n=8) of the patients with appendicitis and 25% (n=2) of them had appendicoliths. The presence of appendicoliths was not significantly associated with the occurrence of perforation (p=0.485). Periappendiceal inflammation scores were 1.52±0.74 in the group with appendicoliths and 1.42±0.63 in the group without appendicoliths (p=0.591).

CONCLUSION: The prevalence of CT-detected appendicoliths was 32.5% in pediatric patients with appendicitis. Patients with appendicoliths showed higher inflammation scores and greater appendiceal diameter than those without appendicoliths. These factors may be associated with poor outcomes in patients with appendicoliths treated with antibiotics. Therefore, knowledge of the prevalence of appendicoliths and questioning their presence may guide clinicians when deciding on the suitability of nonoperative treatment in a patient diagnosed with uncomplicated acute appendicitis.

Keywords: Acute appendicitis; appendicoliths; pediatric; prevalence.

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Acute appendicitis is a very common emergency in radiology practice and is one of the main indications of abdominal surgery in young patients. Appendicitis develops secondary to obstruction of the appendiceal lumen and one of the causes of obstruction is appendicolith [1]. An appendicolith (fecalith) is a calcified deposit located within the appendiceal lumen and can be visualized by abdominal direct radiography, ultrasonography

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or computed tomography (CT) in children presenting with acute appendicitis or incidentally in asymptomatic patients. CT is a highly sensitive and specific imaging modality for the diagnosis of acute appendicitis and allows for simultaneous detection of alternative causes of abdominal pain [2].

Although appendectomy is the standard of care in the treatment of acute appendicitis, randomized controlled clinical studies have been conducted in recent years comparing appendectomy with nonoperative antibiotic therapy [3–6]. However, there is no clear consensus on therapeutic effectiveness and selection of suitable patients. There are published studies reporting that the presence of appendicoliths may adversely affect patient outcomes including higher rates of perforation and abscess, and may predict failure of nonoperative management [7–9]. For these reasons, radiographic demonstration of the presence of an appendicolith may play an important role in patient management and selection of treatment method. However, to the best of our knowledge, there are limited literature data available on the prevalence of appendicoliths in the pediatric age group [7, 10].

The primary aim of this study was to determine the prevalence of appendicolith in pediatric patients with histopathologically confirmed diagnosis of acute appendicitis and to investigate the association between the presence of appendicoliths and radiological disease severity.

Highlight key points

- The prevalence of appendicoliths is 32.5% in pediatric patients with acute appendicitis.
- There is a significant association between the presence and size of appendicolith and appendiceal diameter in patients with acute appendicitis.
- The presence of appendicolith may guide the decision on non-surgical treatment of appendicitis.

MATERIALS AND METHODS

Patient selection: Patients under the age of 18 who were admitted to Adiyaman University Research and Training Hospital and operated on a preliminary diagnosis of acute appendicitis between March 2021 and April 2022 were identified retrospectively. Among these patients, those with histopathologically confirmed diagnosis of acute appendicitis and preoperative abdominal CT images were included in the study.

Data collection and CT protocol: Demographic data and CT images of the patients (n=240) included in the study were reviewed using the standard picture archiving and communication systems (PACS) database of the hospital (Karmed PACS Viewer). The presence of an appendicolith and if present, its longest diameter in the axial plane on CT images, and its visibility on direct radiographs, appendiceal diameter, and severity of inflammation were evaluated radiologically. Inflammation severity was rated on a 3-point scale subjectively (1, mild; 2, moderate; 3, severe) as described by Ranieri et al. [11]. In addition, the presence of perforation was examined histopathologically.

All imaging studies were performed with multidetector CT scanner (Aquilion 64-slice system, Toshiba Medical Systems, Otawara, Japan) using the following scan parameters: 120 kVp with modulated tube current, pitch factor 0.6 mm, and slice thickness 2–3 mm. All images were examined on a standard PACS workstation.

Approval for the study was obtained from Adiyaman University Ethics Committee for Non-Interventional Clinical Studies on May 24, 2022 (No. 2022/5-10).

Statistical Analysis

Statistical analyses were conducted to compare patients diagnosed with acute appendicitis with or without appendicoliths. The normal distribution of the continuous variables was checked using Kolmogorov-Smirnov test. Based on the results of the normality test, the association of the presence of appendicolith and appendiceal diameter with the degree of inflammation was analyzed using Mann–Whitney U test. Spearman's rank test was used to assess the correlation between the size of appendicolith and appendiceal diameter. The relationship between the presence of appendicolith and the prevalence of perforation was analyzed using Fisher's exact test. Statistical analyses were carried out using SPSS version 23.0 (IBM Corp., Armonk, NY), and $p<0.05$ indicated a statistically significant difference.

RESULTS

CT imaging was performed in 77 (32.1%) of 240 patients with histopathologically confirmed diagnosis of acute appendicitis. 39% (n=30) of the patients were girls and the median (min-max) age of the study sample

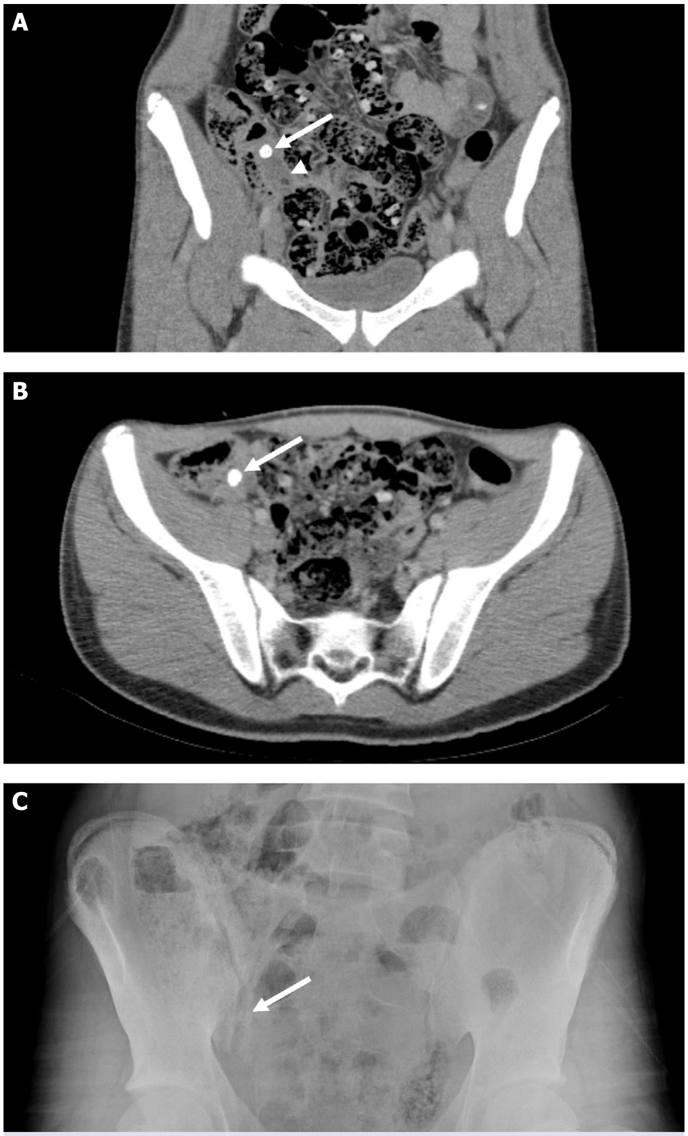

FIGURE 1. Nodular hyperdense appearance of an appendicolith (white arrow) obstructing the appendiceal lumen seen on coronal **(A)** and axial **(B)** planes of abdominal CT images from a patient with appendicitis (arrowhead shows the inflamed appendix). Nodular opacity of the appendicolith (white arrow) seen on direct abdominal radiograph **(C)** of the same patient.

was 13 (3–18) years. The prevalence of appendicoliths detected on CT scans was 32.5% (n=25) in the entire study population. The median (min–max) size of appendicoliths was 6 mm (2–18 mm). There were a total of 17 patients in whom the presence of appendicoliths was demonstrated by abdominal CT, and direct abdominal radiographs were also available. In only 1 (6%) patient, appendicolith could also be detected by direct abdominal radiography (Fig. 1).

The median (interquartile range) appendiceal diameter was significantly greater in the group with appendicoliths 10 mm (8.5–12) than in the group without appendicoliths (8 mm [6–9]; p=0.001, z=-3.622). A moderate positive correlation was found between the appendicolith size and appendiceal diameter (r=0.407, p=0.043). Histopathologically confirmed perforation was present in 10.4% (n=8) of the patients diagnosed with acute appendicitis and 25% (n=2) of them had appendicoliths. No significant association was found between the presence of appendicoliths and the occurrence of perforation (p=0.485).

Periappendiceal inflammation scores were 1.52±0.74 in the group with appendicoliths and 1.42±0.63 in the group without appendicoliths but the difference between the groups was non-significant (p=0.591).

DISCUSSION

Currently, appendectomy is still the gold standard treatment for the management of acute appendicitis. On the other hand, there are many studies evaluating the therapeutic effectiveness of antibiotic therapy for the treatment of uncomplicated acute appendicitis, with conflicting results in terms of treatment success [3–6, 12, 13]. While some studies state that antibiotic therapy is safe and effective and should be regarded as an initial therapeutic option in uncomplicated appendicitis [6, 12, 13], others suggest that nonoperative treatment may not be considered the first-line treatment for all cases of uncomplicated appendicitis [4, 14]. However, there are differences across these studies including variations in the definition of uncomplicated appendicitis, and study inclusion and exclusion criteria, which may be a source of potential bias. As an example, the diagnosis of complicated appendicitis was made based on clinical features alone in some studies, whereas others included CT-confirmed cases to reduce diagnostic uncertainty. Similarly, while the presence of appendicoliths has been considered as complicated appendicitis in some studies [3], it was ignored in others [5]. Thus, patient selection is a critical factor for evaluating the success of non-surgical management of appendicitis and this is still a widely debated topic in the absence of clear consensus on the selection of suitable candidates.

In a study by Vons et al. [5] comparing surgery and antibiotic treatment, the presence of appendicoliths on preoperative CT scan was the only factor that was found to be associated with a significantly increased risk of complicated appendicitis. Mahida et al.'s study [7] investigating the effectiveness of nonoperative treatment in pediatric patients with uncomplicated acute appendicitis with appendicoliths detected on preoperative imaging was terminated prematurely due to an unacceptably high failure rate. Therefore, it has become increasingly important to be aware of the prevalence of appendicoliths, to investigate their presence radiologically, and to report them on patient file to ensure optimal patient selection and ideal clinical management of patients with antibiotics.

In a study by Ranieri et al. [11], the prevalence of appendicoliths was 38.7% (96/248) in adult patients diagnosed with acute appendicitis who underwent CT imaging for suspected acute appendicitis. In the same study, patients with both appendicitis and appendicoliths showed a greater likelihood of perforation (2.07 vs. 1.51) and higher inflammation scores (1.75 vs. 1.43) compared to patients with appendicitis without appendicoliths, respectively. Consistently, in our study, the prevalence of CT-detected appendicoliths was 32.5%, with a greater appendiceal diameter (median 10 mm vs. 8 mm, p=0.001) and a higher inflammation score (statistically non-significant) (1.52 vs. 1.42, p=0.591) observed in patients with appendicoliths than in patients without appendicoliths. In addition, it was demonstrated that appendiceal diameter increases with increasing appendicolith size (r=0.407, p=0.043) but no significant difference was found between the groups in the prevalence of perforation. This may be explained by the small number of patients with perforated appendicitis or the fact that clinically suitable patients diagnosed with uncomplicated acute appendicitis are mostly treated with antibiotics at our center.

Studies evaluating the prevalence of appendicoliths in pediatric patients are scarce. In a study by Lowe et al. [10] involving 60 pediatric patients diagnosed with appendicitis, the prevalence of appendicoliths identified on CT without contrast material was 65% (39/60). In Abeş et al.'s study [13] comparing the outcomes of antibiotic therapy with those of surgical treatment in 205 pediatric patients diagnosed with acute appendicitis, the overall prevalence of appendicoliths was 29% versus 46% (39/85) in patients undergoing surgery. In that study, the prevalence of appendicoliths was assessed using ultrasound (US) or CT imaging and compared to our study, a relatively higher rate of appendicoliths was found in surgically treated patients. We think that this difference is mainly related to the difference in the methods used since it is known that appendicoliths are calcified deposits, which can be detected by ultrasound even before they reach a high density to be visible on CT. In the same study, the prevalence of appendicoliths was higher in patients with failed antibiotic therapy (42%) than in patients with successful antibiotic therapy (14%; p=0.014), which underscores the importance of the presence of appendicoliths in patient selection.

Some limitations should be noted for this study. First, antibiotherapy approach is actively employed for suitable patients with uncomplicated appendicitis at our center. In our study, we included patients with histopathologically confirmed diagnosis of appendicitis who underwent surgery. This might have affected our findings. Secondly, since appendicoliths were detected by CT in our study, luminal deposits that have not been sufficiently calcified might have been missed on CT scans when they could be identified with US. This should be taken into account as US imaging is used more frequently for the diagnosis of acute appendicitis in the pediatric population.

Conclusion

The prevalence of CT-detected appendicoliths was 32.5% in pediatric patients with histopathologically confirmed acute appendicitis. Patients with appendicoliths showed higher inflammation scores and greater appendiceal diameter than their counterparts without appendicoliths. These factors may be associated with poor outcomes in patients with appendicoliths treated with antibiotics. Therefore, knowledge of the prevalence of appendicoliths and questioning the presence of appendicoliths may guide clinicians when deciding on the suitability of nonoperative treatment in a patient diagnosed with uncomplicated acute appendicitis.

Ethics Committee Approval: The Adiyaman University Clinical Research Ethics Committee granted approval for this study (date: 24.05.2022, number: 2022/5-10).

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