Research Square

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Gut Check! Effectiveness of Emergency Room Investigations for Acute Appendicitis

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Abstract

Purpose

Ultrasound (US) is the most used imaging modality in children with suspected appendicitis, with high sensitivity and diagnostic accuracy. Our institution utilizes a standardized US findings reporting system evaluating for appendicitis, which may obviate the need for CT scan if findings are consistent with appendicitis. In this study, we aimed to characterize the efficacy of our protocol for emergency room appendicitis workup and identify any risk factors contributing to a missed diagnosis. We hypothesize that < 10% of patients who underwent appendectomy presented within the preceding 14 days with symptoms of abdominal pain and our current investigative framework failed to identify acute appendicitis.

Methods

We conducted a single institution retrospective review of all pediatric patients who underwent laparoscopic appendectomy from 2020 to 2022 to determine the rates of prior presentation to the emergency department with a negative workup for acute appendicitis in the 14 days prior to formal diagnosis of acute appendicitis. Demographics and clinical characteristics were collected. Differences between groups were compared by using the Fisher's Exact Test or Chi-Square test for categorical variables.

Results

A total of 1902 patients met inclusion criteria with a median age of 11.4 years (IQR 8.3, 14.4). Most patients were male (N = 1,094, 58%), white (N = 1,244, 65%), English speaking (N = 1,695, 89%) Sixty-two patients (3.3%) were seen in the emergency department for abdominal pain within 14 days prior to appendicitis diagnosis, and an additional six patients (0.3%) were seen within the prior 30 days. These patients were younger with a median age of 7.4 years (N = 4, 12.5%) (p = < 0.001) and more likely to be non-English speaking (N = 17, 27%) (p = < 0.001). Thirteen (21%) patients had an ultrasound at initial presentation, and an additional three (5%) had a CT scan. Ultrasound findings included: Category 1 (N = 2), Category 2 (N = 5), indeterminate (N = 1), free fluid (N = 1), dilated appendix (N = 1). At the time of discharge on initial presentation, these patients were diagnosed with constipation (N = 7), abdominal pain (N = 22), gastroenteritis (N = 14), and other (N = 10). Surgery was consulted on 8% (N = 5) of these cases. Missed appendicitis patients had a higher rate of perforation (45.2% vs 27.7%, p < 0.001) and longer mean length of stay (56 hrs vs 9 hrs, p < 0.001).

Conclusion

Patients who presented with acute appendicitis after an initial missed diagnosis are more likely to have perforation and longer inpatient LOS. While a protocolized emergency room diagnostic workup for appendicitis is effective, barriers to effective communication with patients may contribute to missed diagnosis and should be considered in clinical decision making.

Introduction

Appendicitis is the most common condition requiring urgent surgical operation in children. The evaluation of patients with suspected acute appendicitis includes a thorough history and physical examination, laboratory investigation, and imaging. Laboratory tests in conjunction with various patient presentation often lack the sensitivity required to accurately diagnose appendicitis [1]. Therefore, high clinical suspicion is imperative for a timely management.

Ultrasound is the standard imaging modality for diagnosing appendicitis in children with high sensitivity and specificity which have led to reduction of negative appendectomies [2, 3]. Previous studies show that in the hands of experienced sonographers, ultrasound has a sensitivity of 88–89% with a diagnostic accuracy of 94–97% [1, 4, 5] in children. A recent meta-analysis study showed that in the pediatric population, the sensitivity and specificity of US in detecting simple and/or complicated appendicitis was overall 49.6% and 73.5%, respectively [6].

Our institution utilizes a standardized reporting system for ultrasound findings evaluating appendicitis (Fig. 1). If ultrasound is non-diagnostic, CT imaging of the abdomen and pelvis is utilized. However, a major concern with CT scan is radiation exposure, particularly in children. Limited-range CT scans are therefore utilized in children to reduce the radiation dose. In this study, we aimed to characterize the efficacy of our protocol for emergency room appendicitis workup and identify any risk factors contributing to a missed diagnosis. We hypothesized that < 10% of patients who underwent appendectomy presented within the preceding 14 days with symptoms of abdominal pain and our current investigative framework failed to identify acute appendicitis.

Methods

After Institutional Review Board approval of the study (#00002571), we conducted a single institution retrospective review of patients less than 18 years old who underwent laparoscopic appendectomy from January 1, 2020, to December 31, 2022.

Institutional sonographic reporting system

Our institution’s standardized reporting system for ultrasound findings evaluating appendicitis is categorized into four results:

1: Normal appendix

Category 2: Appendix not fully visualized without secondary signs

Category 3: Appendix not fully visualized with secondary signs

Category 4: Appendicitis

The following table shows the sonographic framework of our protocol for diagnosing acute appendicitis which may be found in the body of the ultrasound result.

Visualized	Category I	Category II	Category III	Category IV
	yes	partial/fully	partial/fully	partial/fully
Dilated appendix	no	no/borderline	yes	yes
Incomprehensible	no	no	yes	yes
Peritoneal fluid	no	no	no/yes	yes
Abnormal mesenteric fat	no	no/subtle	yes	yes
Abnormal lymph nodes	no	no	yes	yes
Appendicolith/Fecalith	no	no	yes	yes
Focal tenderness with probe	no	no	no/yes	no/yes
Abscess	no	no	no	yes
Peri-appendiceal fluid	no	no	yes	yes
RLQ: right lower quadrant				

Ultrasound reports were reviewed for their findings and final impression based on the standardized protocol. In the body of the report, key words describing sonographic findings include appendiceal dilation, abnormal echogenic mesenteric fat, per-appendiceal fluid, free peritoneal fluid, appendicolith, abscess, non-compressible, right lower quadrant tenderness with ultrasound probe, and abnormal lymph nodes. Images themselves were not reviewed to confirm the sonographic reports. Further classification for analysis based on the protocol for the purpose of this study include category I-IV, in addition, to the secondary signs.

Data collection

Patients' demographic and clinical data, including age, weight, body mass index, presenting symptoms, laboratory tests if available, and reported imaging findings were collected.

Operative reports were reviewed. Pre-procedure and post-procedure diagnoses were reviewed in addition to intra-operative findings reported for signs of inflammation and/or perforation.

Gross pathology evaluation and histopathology reports were reviewed to confirm appendicitis. Key words in the pathology/histologic reports include transmural inflammation, inflammatory cell infiltrates in mucosa, muscularis propria and/or serosa, and architectural damage including wall necrosis, and perforations. Patients with histopathological findings without evidence of inflammation, isolated reports of helminths, and/or lymphoid hyperplasia were excluded for pathological diagnosis of acute appendicitis. Appendectomies performed as part of another procedure without pathological evidence of inflammation were also considered non-diagnostic for acute appendicitis.

We utilized the standard definition of a negative appendectomy as previously described. Briefly, it is the absence of inflammatory cell infiltrates in the appendiceal wall and/or no other significant pathologic change identified in the appendectomy surgical specimen [7]. Alternatively, negative appendectomy was characterized

by final pathological findings of an appendix that is normal, congested, showed signs of peri-appendicitis, or had a tumor, but without any evidence of inflammation [7, 8].

The primary objective was to determine the rates of emergency department visits after negative workup(s) for acute appendicitis in patients who ultimately require an appendectomy. The secondary objectives were to determine the utilization of computed tomography (CT) imaging following an abdominal US to diagnose appendicitis, the rate of positive sonographic findings with concurrent negative appendectomies, and outcomes in patients with missed diagnosis of appendicitis on initial presentation to the emergency department (ED).

Statistical analysis

Patients' demographics and clinical characteristics were descriptively analyzed. The Kolmogorov-Smirnov test was used to assess the normality of continuous variables. Normally distributed variables are presented as mean ± standard deviation, while non-normally distributed variables are reported as median with interquartile range (IQR). Categorical variables are presented as numbers and percentages.

A subgroup analysis was performed on patients who presented to the ED prior to diagnosis of acute appendicitis. For comparison of continuous variables, the unpaired T test was used whereas Chi-squared or Fisher exact tests were applied for categorical variables. A 2-tailed p-value of < 0.05 was considered statistically significant. All analyses were conducted using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY).

Results

A total of 1902 who underwent appendectomy for suspected appendicitis were included. The mean age was 11.2 years (SD 3.9) (Table 1). Most patients were male (N = 1,085, 58%), white (N = 1,230, 65%), and English speaking (N = 1,678, 89%). The common presenting symptoms were nausea (N = 1313, 70%), emesis (N = 1004, 53%), abdominal pain (N = 652, 35%), fever (N = 590, 31%), diarrhea (N = 297, 16%), and constipation (N = 153, 8%).

A total of 1276 (67%) patients had abdominal US as the first line imaging modality. 48 (4%) of US were obtained at an outside facility. Resultant abdominal US category I diagnosis was 11 (0.6%), category II diagnosis 139 (7%), category III diagnosis 100 (5%), and category IV diagnosis 948 (50%). Our contingency table results showed that patients with category IV findings are likely to have complicated appendicitis (Table 2).

Findings associated with US category I studies were dilated appendix (N = 2, $p < 0.001$) and appendicolith/fecalith (N = 2, $p = 1.000$).

US category II studies were associated with appendiceal wall thickening (N = 4, $p < 0.001$), dilated appendix (N = 3, $p < 0.001$), free fluid (N = 11, $p < 0.001$), and indeterminate finding (N = 1, $p = 0.509$).

US category III studies associated findings were appendiceal dilation (N = 33, $p < 0.001$), appendicolith/fecalith (N = 3, $p < 0.001$), compressible (N = 3 $p = 0.166$), perforation (N = 3, $p = 0.269$) free fluid

(N = 48, p = 0.088), and indeterminate finding (N = 1, p = 1.000).

US category IV studies were significantly associated with perforation (N = 68, p < 0.001), wall thickening (N = 276, p < 0.001), dilation (N = 810, p < 0.001), appendicolith (N = 220, p < 0.001), incompressible (N = 935, p = 0.793), and free fluid (N = 433, p < 0.001), and less likely to be indeterminate (N = 0, p < 0.001).

62 (3.3%) initially presented to the ED 2 weeks prior to appendicitis diagnosis ultimately requiring appendectomy. An abdominal US was obtained in 12 (26%) patients with findings of Category I study (N = 2), Category II study (N = 5), intermediate finding (N = 1), free fluid (N = 1), and dilated appendix (N = 1). Surgery was consulted on 8% (N = 5). Discharging diagnoses from the ED include abdominal pain 20 (43%), gastroenteritis (27%), and constipation (15%). Among these patients, 6 (13%) had acute appendicitis and 4 (9%) had perforated acute appendicitis confirmed on pathology. Patients with missed appendicitis are more likely to have perforation (N = 24, 52% vs N = 13, 28%, p < 0.001) and a longer mean length of stay (56 hrs vs 9hrs, p < 0.001).

A total of 921 (72%) patients were diagnosed with acute simple appendicitis and 360 (28%) with perforated appendicitis **(Fig. 1)**. Five (0.4%) patients were COVID19 positive, requiring interval/delay in appendectomy while 6 (0.5%) patients had perforated appendicitis that were initially treated with drainage by interventional radiology. Ultrasound categories consistent with perforated appendicitis findings were observed in category IV studies (N = 187, 78%), category III (N = 28, 12%), category II (N = 22, 9%), and category I (N = 2, 0.8%). A positive US study with Category III and IV findings have a combined 83% detection rate for perforation (10% and 73%, respectively) in concordance with pathological diagnosis of perforated appendicitis.

308 (24%) who had US had a subsequent CT scan. CT scan was obtained following an US category I finding (N = 11, 3.5%), category II ((N = 138, 45%), category III (N = 74, 24%), and category IV (N = 33, 11%). Specific sonographic findings associated with obtaining CT scan were US obtained from OSH (N = 20, 5.5%), intermediate findings (N = 29, 9.4%), perforation (N = 9, 2.9%), wall thickening (N = 29, 9.4%), compressible (N = 4, 1.2%), dilated (N = 63, 20%), appendicolith/fecalith (N = 13, 4.2%), and free fluid (N = 72, 23%). Among these, forty-six (15%) had negative appendectomies with most patients having lymphoid hyperplasia as the histopathological diagnosis. Twenty (43%) of these were Category II studies while 16 (35%) had sonographic findings of dilated appendix only. Category IV study accounted for 17%, while Category III and I studies accounted for 13% and 4% of these negative appendectomies, respectively. The CT scan reports in all these cases had finding of wall thickening (N = 8, 17%), wall enhancement (N = 10, 22%), peri-appendiceal inflammatory changes (N = 25, 54%), free fluid (N = 17, 37%), appendicoliths (N = 12, 26%) and/or appendiceal dilation of at least 7mm (N = 23, 50%).

Overall, one hundred and seventy (13%) patients who were diagnosed with acute appendicitis had no inflammatory process or structural abnormality on pathology (Table 3). The common pathological diagnoses were lymphoid hyperplasia with or without fecalith, neuroendocrine tumor, fibrosis, and obliteration of the appendix (Table 4).

Discussion

The rate of missed appendicitis among patients who returned to the ED after an initially negative workup using our institutional protocol was 3.3%. As we expected, Category I and II sonographic findings are non-diagnostic for acute appendicitis whereas patients with Category III and IV findings are more likely to have acute appendicitis with 90% accuracy. Additionally, a positive US study with Category III and IV findings have a combined 83% detection rate for perforated appendicitis. Despite these favorable diagnostic category findings, 24% of patients underwent CT scan of the abdomen and pelvis to confirm diagnosis. The rate of negative appendectomies, as defined as lack of inflammatory process and structural damage on gross and histopathology, was 13%.

Standardized categorization of ultrasonographic findings has been proposed as an effective strategy to improve reporting consistency in the evaluation of suspected acute appendicitis [9, 10]. However, the diagnostic performance remain highly the diagnostic performance remains highly dependent on the visualization of the appendix and the experience of the sonographer which are key in identifying primary and secondary sonographic signs of inflammation, impacting whether the exam is diagnostic or inconclusive [1, 11, 12, 13, 14]. We report an accuracy of 90% detection rate using our four category US findings which is comparable to previous studies using three category and five category sonographic reporting system [9, 10, 15].

Among patients who had a misdiagnosis of appendicitis and returned to the ED with findings consistent with acute appendicitis, the initial US findings were consistent with Category I and II studies. These sonographic evaluations often demonstrated intermediate exams, non-specific peritoneal fluid that was not consistent with an abscess, or dilated appendix without additional secondary signs. Category III and IV studies were more likely to be diagnostic for acute appendicitis, including complicated appendicitis as they were significantly associated with complex inflammatory processes, including perforation, supporting their diagnostic value for both simple and complicated acute appendicitis. Consistent with these findings, prior studies have similarly shown that more complex US results were associated with the presence of peri-appendiceal free fluid likely secondary to a perforation without abscess formation, presence of perforation with abscess, and organized abscess formation in the diagnosis of acutely complicated appendicitis [2, 6]. Although the overall incidence of missed diagnosis of appendicitis was low and comparable to rate reported in a large retrospective study, these patients were more likely to return to ED with appendiceal perforation and prolonged hospital stay consistent with prior studies [16].

The rate of negative appendectomy in our study was 13% which is lower than the historically reported range of 15 to 25% [7, 8, 17]. The interpretation of negative appendectomies should consider the variability among institutions in their pathological definition of negative appendectomy. As previously noted in other studies, some institutions follow strictly negative transmural inflammation to establish a negative diagnosis, while others may classify the presence of mucosal infiltration or any pathological abnormality as a positive marker for acute appendicitis [7, 8, 18]. In our study, most of the negative appendectomies were secondary to pathological finding of lymphoid hyperplasia with or without fecaliths. A previous study suggests that differentiating the size of lymphoid hyperplasia which is characteristically a hypoechoic band of the appendix measuring at least 0.8 mm along with a thicken (1 mm) lamina propria are signs that inversely correlated with acute appendicitis [19, 20]. Incorporating these sonographic characteristics and markers into our algorithm

may help increase the confidence of ruling out lymphoid hyperplasia as a false positive sonographic diagnosis.

CT scan imaging remains an important adjunct in cases of inconclusive sonographic findings or discordant clinical presentations. An analysis of the 2016 American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database showed that obtaining CT scan to confirm ultrasound findings decrease the rate of negative appendectomies to 4.5% [17]. However, in that study, approximately 15% and 86% of patients had US and CT scan, respectively. Their negative appendectomies ranging from 0.6–10.5% for CT confirmed US diagnosis of appendicitis, indeterminate, or non-diagnostic findings compared to US alone 4.8–27.2% [17]. In our cohort, CT scans were frequently obtained following Category II and III sonographic findings, reflecting diagnostic uncertainty. A previous study suggested that US may be more specific and likely less sensitive in diagnosing complicated appendicitis which may be a factor in our classifications of Category II and III studies with a considerably discordant clinical presentation [6]. However, a detection rate of 83% in complicated appendicitis consistent with Category III and IV findings is arguably good.

Our findings also support broader application of our classification system in our hospital system for pediatric patients evaluated at general hospitals with advanced imaging capabilities. There was no significant difference in negative appendectomies between transfer and primary patients despite more frequent CT use at non-pediatric facilities [21]. The use of CT following an US in children with suspected acute appendicitis has been reported to be higher during after-hours despite controlling for visualization of the appendix on US suggesting that physicians are likely to default cross-sectional imaging in cases of diagnostic uncertainty [10]. This practice warrants careful consideration as individuals' accumulative radiation exposure increases their lifetime risk of cancer, especially in the pediatric population, which is a public health concern [22, 23, 24]. We must continue to weigh the risk and benefits of advanced imaging studies in children without compromising timely diagnosis and management.

This study is not without limitation. First, this was a retrospective single-center study design, which may limit the generalizability of its findings because our classification protocol and sonographer/radiologist experience and interpretations may be different across institutions. Second, there may be some bias in CT scan utilization among surgeons which might have not been captured in this study. Third, subgroup analysis was not performed to determine factors in patients' presenting symptoms or pediatric appendicitis score, influencing positive pathology confirmed appendicitis. The study focused on patients who underwent appendectomy and determined those who initially had an ultrasound study to determine the rate of negative appendectomies based on our US classification protocol. Fourth, our four-category classification system may contribute to misclassification of some patients which might have increased utilization of CT scan and/or negative appendectomies. Fifth, although this study was performed at a tertiary center, there is a potential for underestimating the true rate of missed appendicitis. Despite these limitations, this study showed that a four-category classification of standardized sonographic signs enables consistent reporting and confidence in diagnosing appendicitis in children. Based on these findings, our institution implemented an updated protocol for diagnosing pediatric appendicitis as shown in Supplemental Fig. 1.

Conclusion

Standardized classification of ultrasonographic findings using four-category reporting protocol showed a high diagnostic accuracy with pathology confirmed acute appendicitis. Patients who presented acute appendicitis following an initial missed diagnosis are more likely to be perforated and longer hospitalization. While a protocolized emergency room diagnostic workup for appendicitis is effective, barriers to effective visualization of the appendix, interpretation of findings, and documentation may contribute to missed diagnosis. Continued efforts to optimize these limitations may further improve diagnostic accuracy while minimizing unnecessary advanced imaging and potential delay in intervention.

Declarations

Competing interests:

The authors have no relevant financial or non-financial interests to disclose.

Ethics approval:

This retrospective study was approved by the Institutional Review Board of Children's Mercy Kansas City (#00002571) and was performed in accordance with the ethical standards of the institutional research committee and the 1964 Declaration of Helsinki and its later amendments.

Consent to participate:

Given the retrospective design of this study, the requirement for informed consent was waived by the Institutional Review Board.

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Author Contribution

Author contributions: All authors contributed to the study conception and design. Data collection and analysis were performed by Efua Bolouvi. The first draft of the manuscript was written by Efua Bolouvi, Seth Saylor and Cory Nonnemacher, and the final manuscript was prepared by Juan Bonilla. Shawn St. Peter and Tolu Oyetunji supervised the study. All authors reviewed the manuscript and approved the final version.

Data availability:

The datasets analyzed during the current study are not publicly available due to patient privacy protections but are available from the corresponding author on reasonable request, subject to institutional and IRB approval.

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Tables

Table 1
Patient demographic and clinical data

***Age*, year, SD**	**11.2 (± 3.9)**
Gender, n (%)	
Male	1085 (58%)
Female	798 (42%)
Race, n (%)	
White	1230 (65%)
Hispanic	282 (15%)
Black or African American	109 (6%)
Multiracial	77 (4%)
American Indian or Alaska Native	3 (0.2%)
Other or no response	182 (10%)
Language, n (%)	
English	1678 (89%)
Spanish	173 (9%)
Mandarin	2 (0.1%)
Other or no response	30 (1.6%)
Insurance status, n (%)	
Private	996 (53%)
Medicaid	756 (40%)
Other	131 (7%)
Weight, kg, median (IQR)	44 (29–60)
BMI, kg/m2, median (IQR)	20 (17–24)
Presenting symptoms, n (%)	
Fever	590 (69%)
Abdominal pain	652 (35%)
Nausea	1313 (70%)
Emesis	1004 (53%)
Diarrhea	297 (16%)
Constipation	153 (8%)

***Age*, year, SD**	**11.2 (± 3.9)**	
White blood cell count, cells/mcL, mean, SD	13, 000 (± 5,400)	
Antibiotic administered, n (%)		
Ceftriaxone	1283 (68%)	
Metronidazole	1011 (53%)	
Piperacillin/tazobactam	154 (8%)	
Augmentin	2 (0%)	
Gentamycin	0 (0%)	
Ciprofloxacin	8 (0%)	
Duration of surgery, hrs, mean, SD	32 min (SD 15)	
Length of stay, hrs, median, IQR	5 hrs (IQR 3–29)	
Recent ED visit, n (%)		
2 weeks prior	62 (3.3%)	
4 weeks prior	6 (0.3%)	
Surgery consults 2 weeks previously, n (%)	5 (8%)	
ED discharge diagnosis, n (%)		
Abdominal pain	24 (44%)	
Gastroenteritis	14 (26%)	
Constipation	7 (13%)	
Other	10 (19%)	
Investigation 2 weeks prior		
US	14 (26%)	
CT abdominal and pelvis	3 (6%)	
None	36 (68%)	
Imaging findings, n (%)	**Ultrasound**	**CT scan**
Intermediate	33 (2%)	
Perforated	74 (4%)	
Compressible	18 (1%)	
Dilated	874 (46%)	
Wall thickening	307 (16%)	155 (8%)

***Age*, year, SD**	**11.2 (± 3.9)**	
Appendicolith	232 (12%)	226 (12%)
Free fluid	507 (27%)	280 (15%)
Peri-appendiceal inflammatory changes		392 (21%)
Wall enhancement		136 (7%)
Appendiceal dilation 7 + mm		378 (20%)

Table 2
Ultrasound category with associated findings in diagnosing appendicitis

	Ultrasound Category											
	I (n = 11, 0.6%)			**II (n = 139, 7%)**			**III (n = 100, 5%)**			**IV (n = 948, 50%)**		
Ultrasound finding	Yes	No	p-value	Yes	No	p-value	Yes	No	p-value	Yes	No	p-value
Indeterminate	0	11	p = 1.000	1	138	p = 0.249	1	99	p = 0.509	0	948	p < 0.001
Perforated	0	11	p = 1.000	0	139	p < 0.001	3	97	p = 0.269	68	880	p < 0.001
Wall thickening	0	11	p = 0.076	4	135	p < 0.001	22	78	p = 0.715	276	672	p < 0.001
Compressible	0	11	p = 1.000	0	139	p = 0.247	3	97	p = 0.160	13	935	p = 0.793
Dilated	2	9	p < 0.001	3	136	p < 0.001	33	67	p < 0.001	810	138	p < 0.001
Appendicolith/ Fecalith	2	9	p = 1.000	0	141	p < 0.001	3	97	p < 0.001	220	728	p < 0.001
Free fluid	1	10	p = 0.058	11	128	p < 0.001	48	52	p = 0.088	433	515	p < 0.001

Table 3
Distribution of patients with acute appendicitis and imaging modality obtained and a subset of patients who presentation to the ED 2 weeks prior

Pathology results	**All patients with initial US who had a follow up CT scan (N = 1283)**		**Subset of patient who had ED visits 2 weeks prior (N = 46)**			
	CT scan	**Total**	**US**	**CT scan**	**No imaging**	**Total**
Acute appendicitis	192	854	6	0	16	22
Perforated appendicitis	69	259	4	0	11	15
Negative appendectomy	46	170	2	3	4	9
Reason for surgery						
Acute appendicitis	213	921	6	3	14	23
Perforated appendicitis	94	362	6	0	17	24

Table 4
Negative appendectomy pathological findings (isolated findings or in combination)

Enterobious vermicularis	**ED visits 2 weeks prior**	**Total**
	1	**11**
Lymphoid hyperplasia	7	122
Fibrosis and/or obliteration of appendix	1	5
No inflammation/appendiceal abnormality	1	23
Neuroendocrine tumor	0	3
Omental torsion	0	2
Meckel's diverticulum (perforated and non-perforated)	0	3
Fecalith	0	27
Intussusception	0	1

Figures

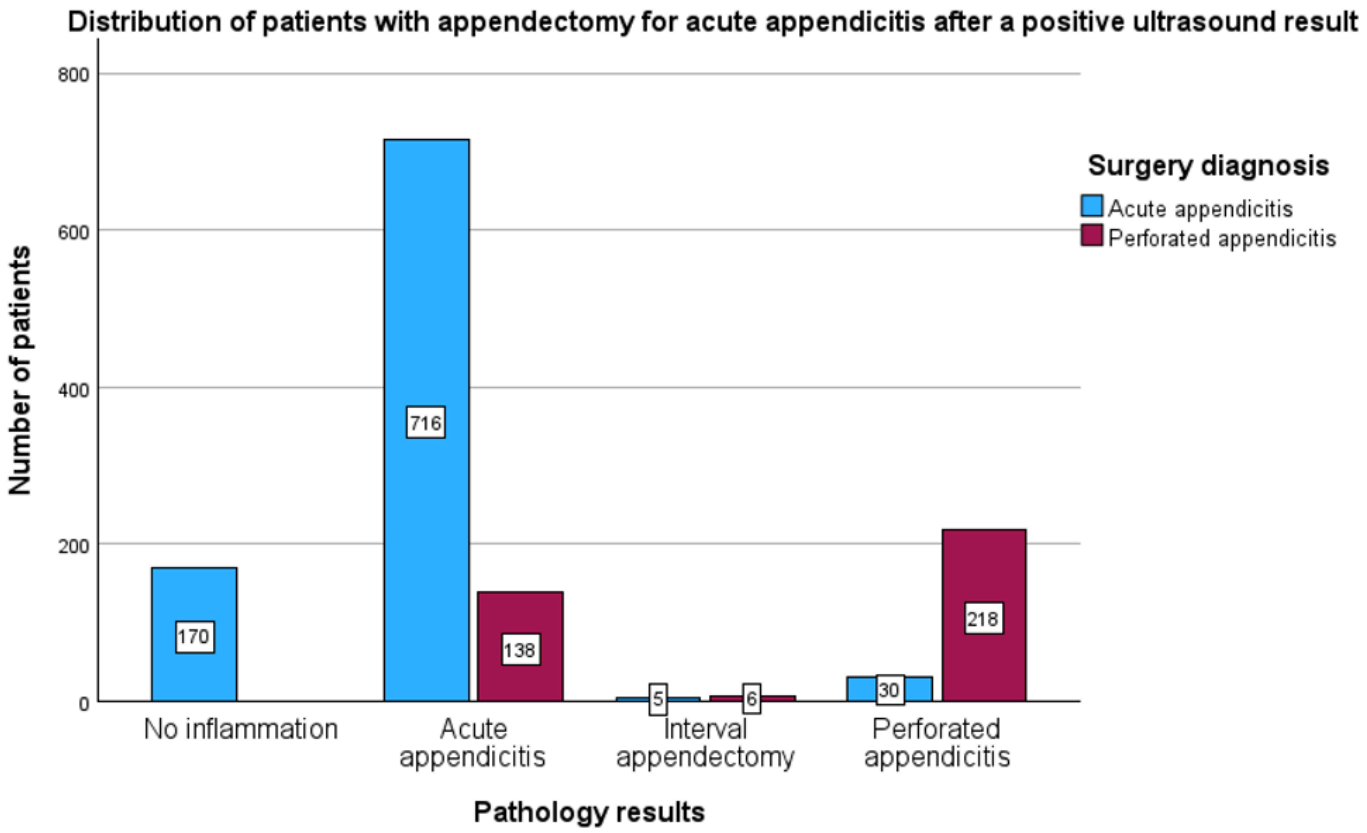


Figure 1

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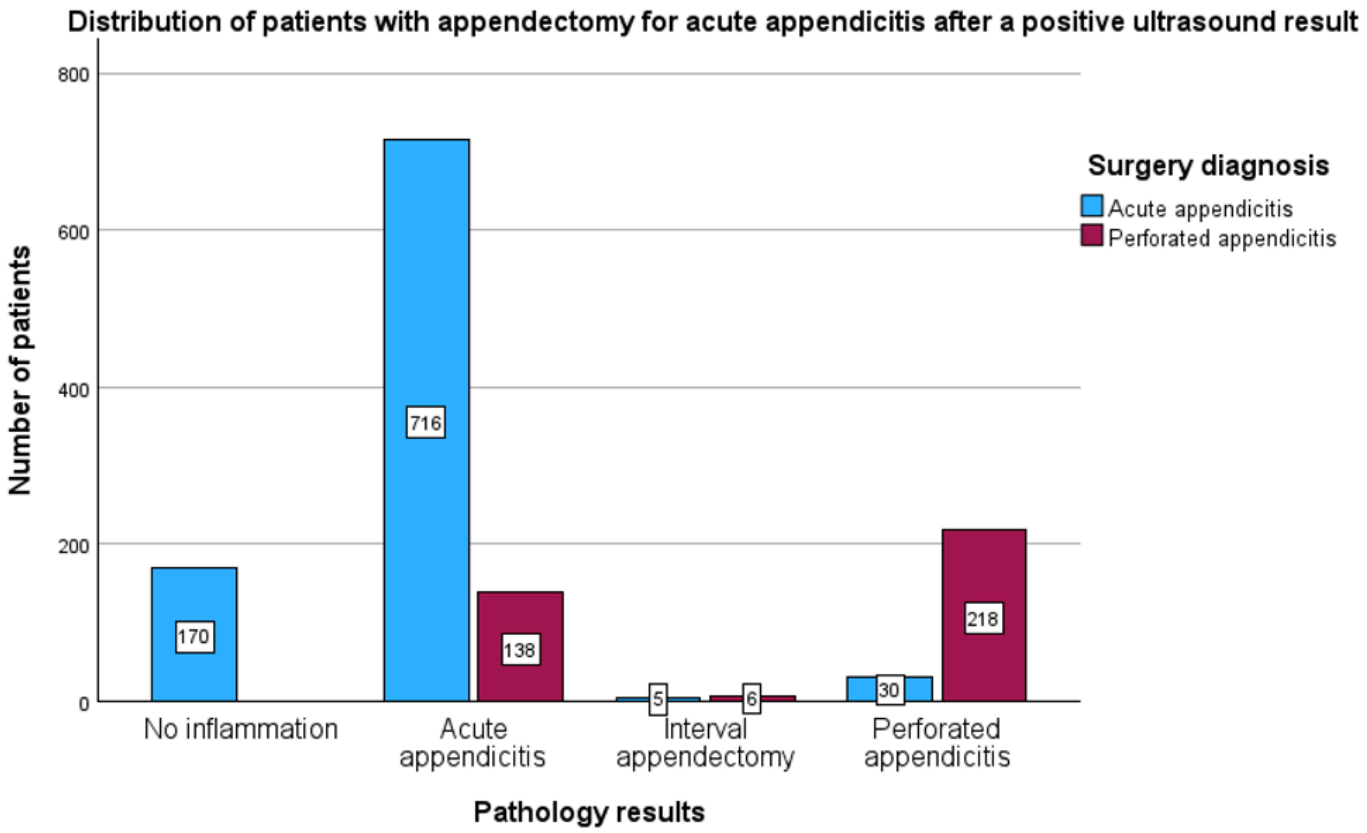


Figure 1

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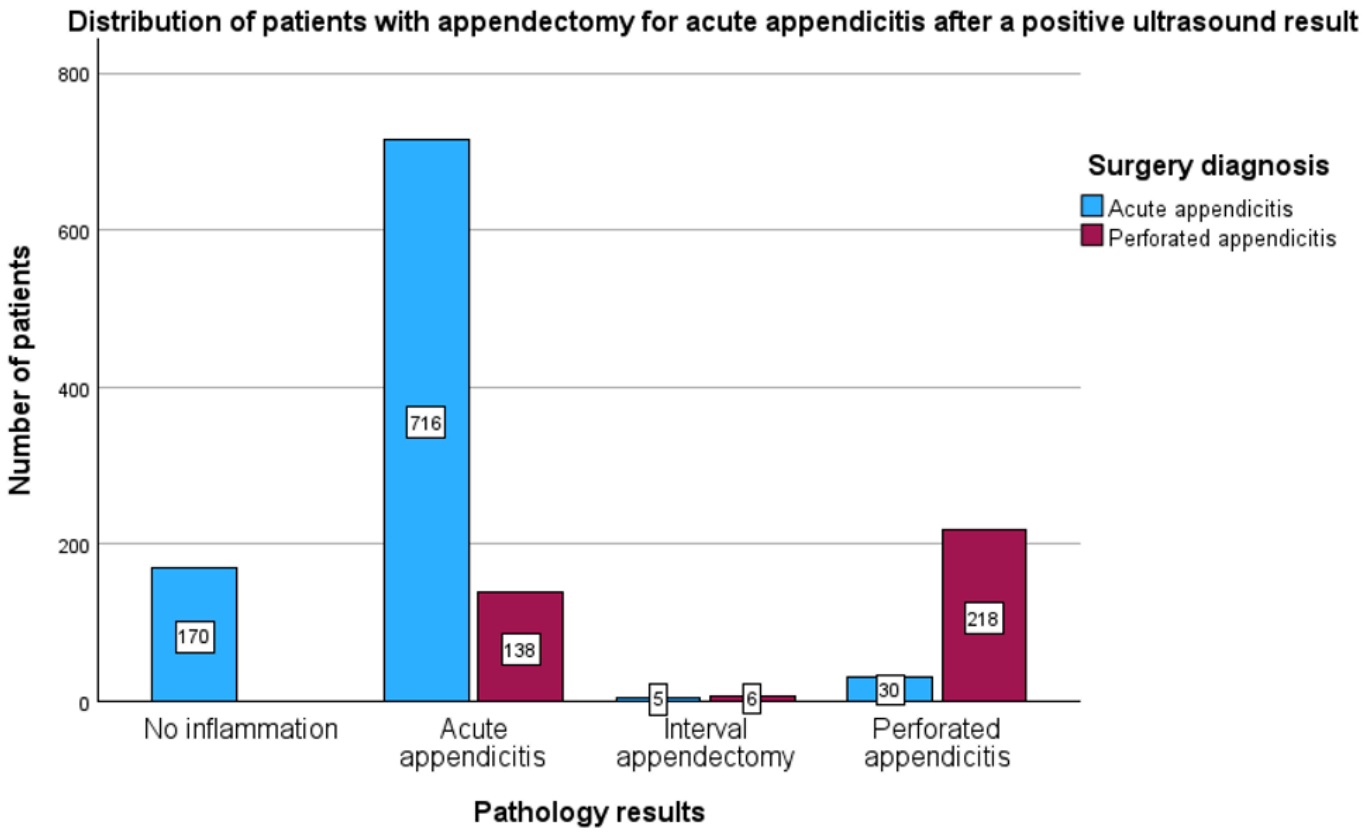


Figure 1

Legend not included with this version.

Supplementary Files

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- SupplementalFigure1andAppendix.docx
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