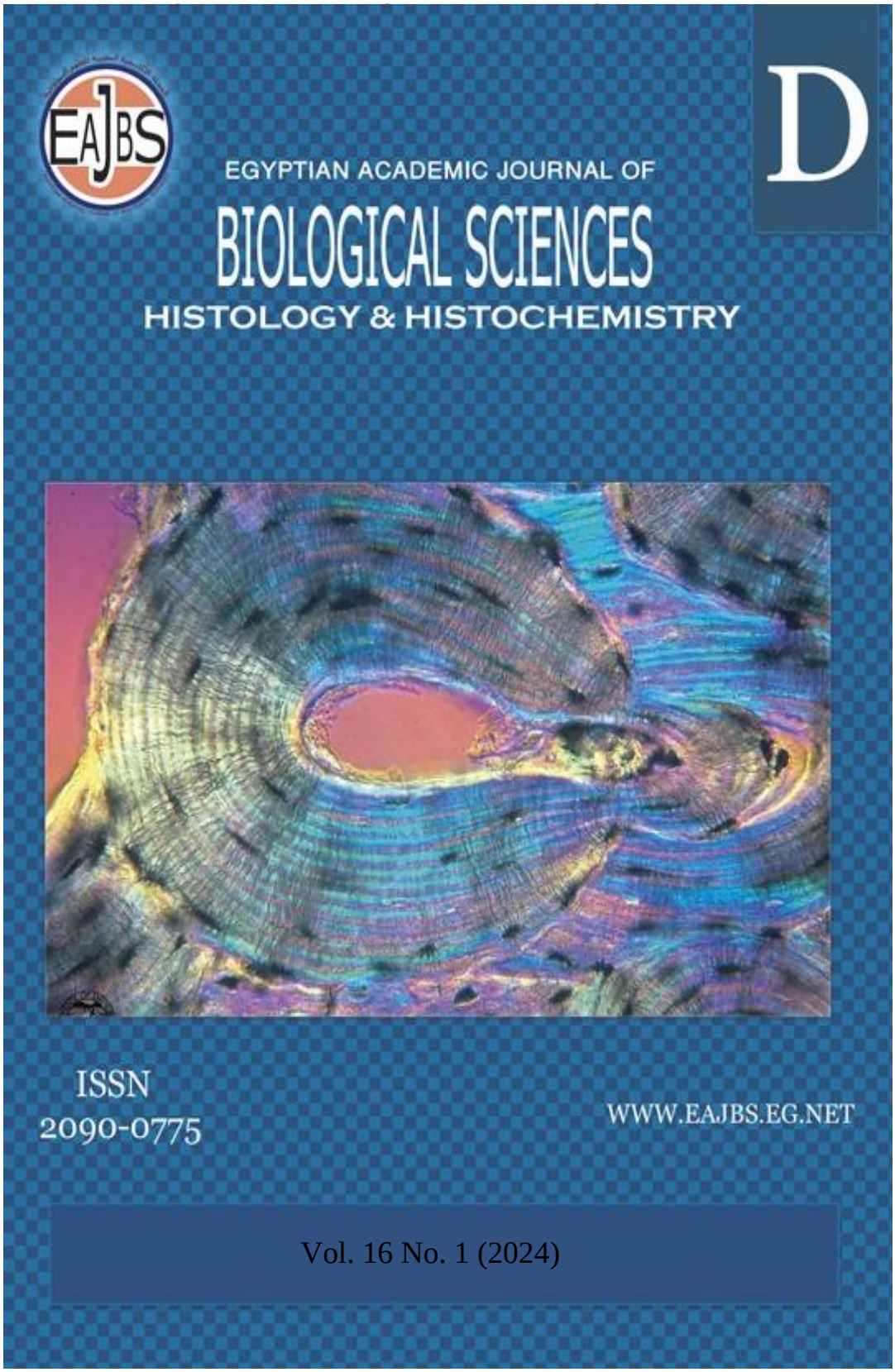

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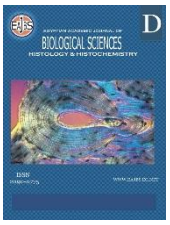

Parasitic Infections as a Neglected Cause of Acute Appendicitis: Value of Routine Pathological Handling of Appendectomy Specimens

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ABSTRACT

Background: The role of parasitic infections in acute appendicitis is still debatable. We aimed to investigate the role of parasitic infections in acute appendicitis as a neglected risk factor in an attempt to early recognition and treatment. **Patients and Methods:** A retrospective study included 1365 patients who underwent appendectomy. Demographic data, presentation, complications, investigation, and pathological reports were obtained from patients' records. Patients were categorized into two groups: group I (n=37), with parasitic infections present, and group II (n=1328) absent parasitic infections. **Results:** The prevalence of acute parasitic appendicitis was 2.7%. The mean age group of patients with appendiceal parasitic infections was 23.86±10.1 years with a male/female ratio of 1.6:1. The detected parasites were 21 (56.8%) *Enterobius vermicularis*, 9 (24.3%) *Ascaris lumbricoides*, 7 (18.9%) *Schistosoma mansoni.* The histopathological examination of acute appendicitis with parasitic infections revealed non-complicated histopathology in 62.2% of specimens, acute catarrhal inflammation in 13.5% of specimens, acute suppurative appendicitis in 16.2%, acutely gangrenous appendicitis in 5.4% of specimens and with schistosomiasis infection there was acutely gangrenous appendicitis with perforation in 2.7% of specimens. Common presenting symptoms in acute appendicitis with parasitic infections were nausea in 86.5%, and periumbilical pain in 78.3%. The complications were significantly common among acute appendicitis patients with parasitic infections (13.5%) compared to those without parasitic infections (4.1%) (p=0.006). There is no reported mortality among studied cases. **Conclusions:** The current study demonstrated that acute parasitic infection is one of the infectious agents that may increase the risk of appendicitis and can be identified postoperatively in the resected appendix. These findings emphasize the importance of considering the neglected role of parasites in acute appendicitis. As a result, early detection and treatment of parasites are recommended for complete eradication.

INTRODUCTION

Appendicitis is still a major public health issue around the world. The cause of acute appendicitis is unknown but is probably multifactorial; however, the most popular theory is appendix lumen obliteration (Gupta *et al.,* 1989; Guan *et al.,* 2023).

Parasitic infections have been implicated in the pathophysiology of pseudo appendicitis. The parasites are often detected only after a pathologic examination of the appendices that have been resected. These parasites have also been thought to cause appendicitis through mucosal invasion, luminal blockage, or both together (da Silva, *et al.,* 2007; Karatepe, *et al.,* 2009).

The role of parasitic infections in acute appendicitis is still being debated. Therefore, this work aimed to investigate the role of parasitic infections in acute appendicitis regarding prevalence, clinical presentation, and outcomes in an attempt to avoid unnecessary surgery and to better manage patients during and after surgery.

MATERIALS AND METHODS

Study Design:

This retrospective study included 1365 patients who underwent appendectomy for presumed acute appendicitis from August 2014 to May 2018 in Khamis Mushait General Hospital, Saudi Arabia.

Study Population:

This study was conducted on 1365 out of 1580 patients with appendectomy (open or laparoscopically).

Patients were divided into two groups, group I (n=37) where parasitic infections were detected, and Group II (n=1328) where parasitic infections were absent. The data were gathered from the hospital's clinical records.

Inclusion Criteria: Patients with appendectomy due to preoperative acute appendicitis. Acute appendicitis was diagnosed based on history, clinical examination, an increased white blood cell count, and imaging studies such as ultrasonography. The number of those included patients was 1365.

Exclusion Criteria: Patients with an acute abdomen of unknown cause, incidental appendectomy due to other surgeries, patients with proven appendiceal cancers after surgery, the histopathology slides or reports that were not accessible for review, or cases that did not meet the diagnostic criteria, were excluded from this study. The number of those excluded patients was 215.

During postoperative follow-up, and after the release of the histopathology reports, individuals with *Enterobius vermicularis* were given a single oral dosage of 100 mg mebendazole, which was repeated 7-10 days later. Mebendazole 100 mg twice per day for three days was provided to *Ascaris lumbricoides* patients. Praziquantel 40 mg/kg taken as a single oral dosage was prescribed for schistosomiasis.

Data Collection:

For each patient, data collected were demographic data (age, sex, nationality, co-morbidities, and length of hospital stay), clinical presentation, physical findings, preoperative imaging, and laboratory results including chemistry, complete blood count, and stool examination, operative reports in addition to gross and microscopic histopathology diagnosis. The type of appendectomy, intraoperative findings, postoperative management, and complications like appendicular perforation were also documented. All cases underwent an open or laparoscopic appendectomy and cases were discharged and followed up in a surgical outpatient clinic for stitch removal and further management after histopathology results.

Histopathology:

All specimens were submitted for routine histopathological evaluation. A tissue-embedded paraffin block was prepared from the appendectomy specimen of each patient. Two sections of 4-µm thickness were prepared from each tissue-embedded paraffin block.

These sections were stained with hematoxylin and eosin stains. Periodic acid Schiff and Ziehl-Neelsen were used wherever necessary. An experienced histopathologist and parasitologist re-evaluated the pathological slides of all appendectomy specimens with parasitic infections. The presence of transmural inflammation or pus in the appendix lumen is defined as acute appendicitis. A negative appendectomy is one in which the appendix is determined to be normal on histological analysis. Positive appendectomy specimens were divided into four groups based on histological signs of acute appendicitis: catarrhal appendicitis, suppurative appendicitis, gangrenous appendicitis, and perforated appendicitis (Marudanayagam, *et al.* 2006).

Post-operative stool examinations for the documented parasitic appendicitis were done in 37 patients which revealed abnormal findings seen in 12 patients (32.4%). Following appendectomy, each appendix was examined by a hand lens and then opened longitudinally to examine the interior by the hand lens for detection of foreign bodies or mature worms. Each appendix's contents were washed with 10% formal saline. The wash was centrifuged for three minutes at 3000 r.p.m., and the sediment was checked microscopically for the presence of ova, larvae, cysts, or trophozoites before sending the appendix for histological investigation.

Outcomes:

The frequency of postoperative complications was our primary outcome. Mortality and length of hospital stay were secondary outcomes.

Statistical Analysis:

SPSS version 20 for Windows (SPSS, Chicago, IL) was used to analyze the data. For quantitative variables mean with standard deviation (SD) was used and the number of cases (percentage) for categorical variables. Categorical data between the two groups were compared using the Chi-squared test or Fisher's exact test. Quantitative data were compared using the Student's T test or Mann-Whitney U test whichever was applicable. Statistical significance was defined as a p-value < 0.05.

RESULTS

Demographic Data of Studied Patients:

In the current study, 1365 patients were included. The mean age of the whole group was 27.9±18 years (range: 6-54 years). Of them, there were 748 (54.8%) males and 617 (45.2%) females, with a male/female ratio of 1.21:1.

The mean age of acute appendicitis patients with parasitic infections was significantly lower than that of patients without parasitic infections (23.86±10.1 Vs 28±11.3; p=0.008). The age group of the studied patients is shown in Table 1.

Table 1: Demographic data of the studied cases**.**

Variables	Appendicitis with parasitic infections N= 37	Appendicitis without parasitic infections N= 1328	p
Age (mean± SD) (years)	23.86±10.1	28±11.3	**0.008**
10-20	10 (27%)	286 (21.5%)	0.42
21-30	16 (43.2%)	670 (50.4%)	0.39
31-40	7 (18.9%)	290 (21.8%)	0.67
41-50	3 (8.1%)	60 (4.5%)	0.30
>50	1 (2.7%)	22 (1.7%)	0.65
Gender			
Males	23 (62.2%)	725 (54.6%)	0.36
Females	14 (37.8%)	603 (45.4%)	0.36
Nationality			
Saudi	28 (75.7%)	1093 (82.3%)	0.30
None Saudi	9 (24.3%)	235 (17.7%)	0.30

N, number; data presented as means± standard deviation (SD) for quantitative variable, number (%) for qualitative variables.

Prevalence, and Types of Parasitic Infections in Acute Appendicitis:

Pathological examinations revealed parasites in 37 specimens (2.7%). Of them, 21 (56.8%) specimens were *Enterobius vermicularis* (Fig. 1), 9 (24.3%) specimens *were Ascaris lumbricoides*, and 7 (18.9%) specimens were *Schistosoma mansoni* (Figure 2). There were no mixed parasitic infections in any of the patients

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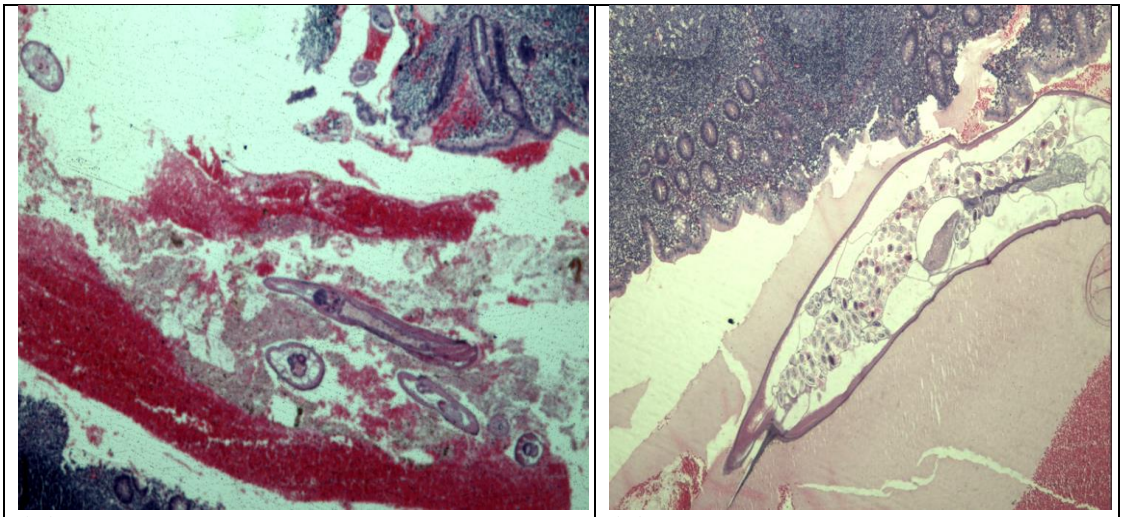
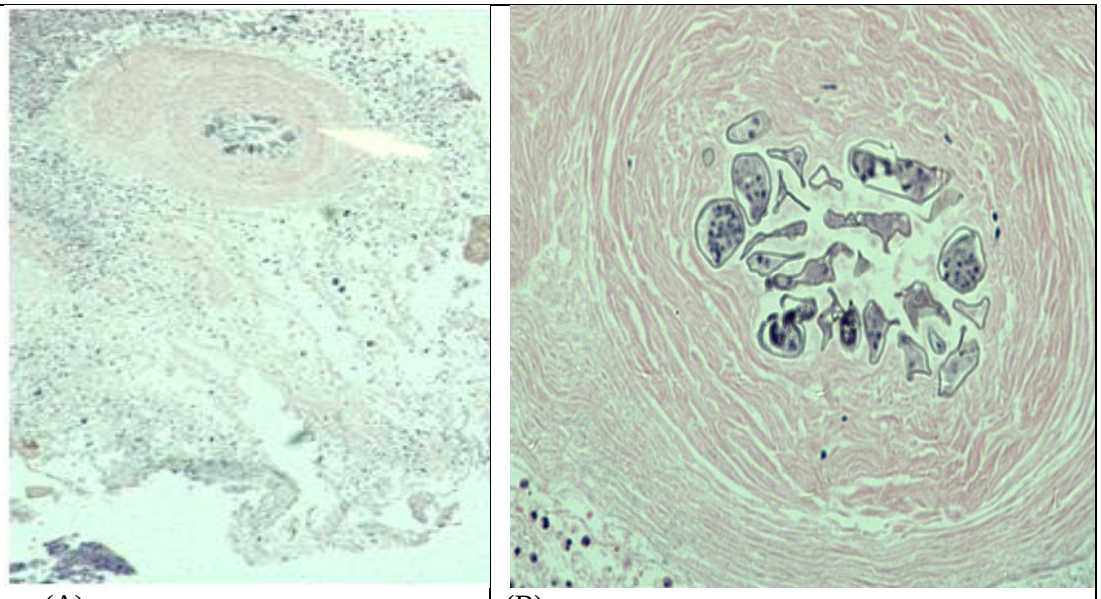


(A) (B)

Fig. 1: (A) Photomicrograph showed the *Enterobius vermicularis* in the lumen of the appendix (HE, low power), (B) Photomicrograph showed *Enterobius vermicularis* in the lumen of the appendix (HE, High power)



(A) (B)

Fig. 2: (A) Photomicrograph showed *Schistosoma* ova within a granuloma (arrow) and surrounded by chronic inflammatory cells' infiltrate (H and E, x40), (B) Photomicrograph showed *Schistosoma* ova within a granuloma and surrounded by chronic inflammatory cells' infiltrate (H and E, x400)

Clinical Presentation, Diagnostic Investigations, And Treatment Modalities of Appendicitis Patients with Parasitic Infections:

Common presenting symptoms in acute appendicitis patients with parasitic infections were nausea in 86.5% of cases, periumbilical pain in 78.3% of cases, right iliac fossa pain in 62.2% of cases, and vomiting in 43.2% of cases. Acute appendicitis patients with parasitic infections showed significantly delayed presentation compared to patients without parasitic infections (p< 0.001) (Table 2).

Table 2: Clinical presentation, diagnostic investigations, and treatment modalities of the studied cases**.**

Variables	Appendicitis with parasitic infections N= 37	Appendicitis without parasitic infections N= 1328	p
Right iliac fossa pain	23 (62.2%)	1249 (94%)	**<0.001**
Periumbilical pain	29 (78.3%)	340 (25.6%)	**<0.001**
Duration of pain mean± SD (hours)	57±7.8	42±8.9	**<0.001**
Anorexia	8 (21.6%)	286 (21.5%)	0.99
Vomiting	16 (43.2%)	674 (50.7%)	0.39
Nausea	32 (86.5%)	862 (65%)	**0.007**
Diarrhea	6 (16.2%)	45 (3.4%)	**0.001**
Constipation	4 (10.8%)	23 (1.7%)	**0.001**
Rebound tenderness	28 (75.7%)	1020 (76.8%)	0.98
Fever	2 (5.4%)	66 (5%)	0.91
Delayed presentation >72 hours	9 (24.3%)	92 (6.9%)	**<0.001**
WBCs count			
$<12x10^9$/L	25 (67.6%)	227 (17.1%)	**<0.001**
$>12x10^9$/L	12 (32.4%)	1101 (82.9%)	**<0.001**
Eosinophilia	23 (62.2%)	33 (2.5%)	**<0.001**
C-reactive protein			
<10 mg/L	21 (56.8%)	98 (7.4%)	**<0.001**
>10 mg/L	16 (43.2%)	1230 (92.6%)	**<0.001**
Ultrasound reliability			
Sensitivity	75%	63.2%	0.14
Specificity	35.3%	49.4%	0.09
PPV	57.7%	75%	**0.02**
NPV	54.5%	35.9%	**0.02**
CT reliability			
Sensitivity	100%	95.7%	0.20
Specificity	75%	83.3%	0.18
PPV	87.5%	95.7%	**0.02**
NPV	100%	83.3%	**0.007**
Treatment modality			
Open appendectomy	29 (78.3%)	1111 (83.7%)	0.38
Laparoscopic appendectomy	8 (21.6%)	217 (16.3%)	0.39
Appendectomy time (Minutes)	48±7.8	51±10	0.07

N, number; PPV, positive predictive value; NPV, negative predictive value; CT, computed tomography; data presented as means± standard deviation (SD) for quantitative variable, number (%) for qualitative variables

Preoperative laboratory studies demonstrated a significantly higher frequency of eosinophilia and C-reactive protein (<10 mg/L) among acute appendicitis cases with parasitic infections compared to cases without parasitic infections (62.2 % Vs 2.5%, for eosinophilia, and 56.8% Vs 7.4%. for C-reactive protein, p < 0.001) (Table 2). On the other hand, preoperative laboratory studies demonstrated a significantly lower frequency of C-reactive protein (>10 mg/L) among acute appendicitis cases with parasitic infections compared to cases without parasitic infections (43.2 % Vs 92.6%, p < 0.001). Postoperative

stool analysis was done for the proven cases with parasitic appendicitis and was positive for the parasite in 15 cases.

The preoperative abdominal ultrasound was done in 66.2%, and the CT scan in 3% of all cases. The sensitivity and specificity of US and CT reliability showed no significant differences between the two appendicitis groups. NPV percentages for the radiologic investigations (US and CT) showed a significantly higher percentage among appendicitis with parasitic infections compared to that without parasitic infections (54.5% Vs. 35.9%, $p < 0.02$ for US reliability, and 100% Vs. 83.3%, $p < 0.007$ for CT reliability). PPV percentages showed a lower value among the parasitic infections group compared to the non-parasitic infections group (57.7% Vs. 75%, $p < 0.02$ for US reliability, and 87.5% Vs. 95.7%, $p < 0.02$ for CT reliability) (Table 2).

Open appendectomy was performed in 29 (78.3%) appendicitis patients with parasitic infections, whereas 8 (21.6%) patients underwent laparoscopic appendectomy. The operation lasted between 30 to 110 minutes on average with a mean duration of 48±7.8 minutes.

Outcomes of Parasitic Appendicitis:

The complications were significantly common among acute appendicitis patients with parasitic infections compared to appendicitis without parasitic infections (p=0.006) as regards pelvic collection, chest infection and the subsequent time of hospital readmission stay. Of them, six (16.2%) appendicitis cases with parasitic infections were readmitted, 3 cases with wound infection and dehiscence, one case with perforation, one case with pelvic collection, and one case with a chest infection.

However, in cases without parasitic infections, 74 cases (5.6%) were readmitted, due to pain in 12 cases (5%), pelvic collection in seven patients (0.53%), wound infection and dehiscence in 48 patients (3.6%), one of them had diabetes mellitus and he developed post-operative diabetic ketoacidosis treated with insulin infusion and medical care at the Intensive Care Unit, three patients (0.23%) with a postoperative chest infection and one patient (0.08%) with fresh rectal bleeding. No reported mortality among all the studied cases. The length of hospital stay was longer among appendicitis patients with parasitic infections compared to cases without parasitic infections (p=0.03) (Table 3).

Table 3: Outcomes of the studied cases

Patient characteristics	Appendicitis with parasitic infections N= 37	Appendicitis without parasitic infections N= 1328	p
Non-complicated	32 (86.5%)	1274 (95.9%)	**0.006**
Complicated	5 (13.5%)	54 (4.1%)	**0.006**
Primary outcome			
Pain	0 (0%)	12 (5%)	0.16
Perforation	1(2.7%)	7 (0.53%)	0.09
Pelvic collection	1 (2.7%)	3 (0.23%)	**0.007**
Wound infection and dehiscence	3 (8.1%)	48 (3.6%)	0.15
Chest infection	1 (2.7%)	3 (0.23%)	**0.007**
Rectal bleeding	0 (0%)	1 (0.08%)	0.86
Secondary outcome			
Mortality	0(0%)	0 (0%)	0.99
Hospital stays			
<2 days	22 (59.5%)	978 (73.6%)	0.06
2-5 days	10 (27%)	278 (20.9%)	0.37
>5 days	5 (13.5%)	72 (5.4%)	**0.03**

N, number; data presented as means± standard deviation (SD) for quantitative variable, number (%) for qualitative variables**.**

Distribution of the Histopathological Results of Appendicitis (Table 4):

Histopathology examination of acute appendicitis with parasitic infections revealed significantly higher percentage of non-complicated histopathology results compared to the non-parasitic group (62.2% Vs. 3.2%, $p < 0.001$), while the parasitic group showed significantly less percentage as regards acute catarrhal appendicitis compared with the non-parasitic group (13.5% Vs. 21.6, $p < 0.003$). Acute suppurative appendicitis is significantly less in the parasitic group than in the non-parasitic group (16.2% Vs. 65.6%, $p < 0.001$). No significant difference is shown between the two groups as regards acute gangrenous appendicitis (5.4% Vs. 8.2%, $p < 0.06$), while the parasitic group showed a significantly higher percentage as regards perforated acute gangrenous appendicitis with schistosomiasis infection (2.7% Vs. 1.4%, $p < 0.03$). Microscopically, eosinophilic infiltration between the two groups was 89.2% Vs. 0%, ($p < 0.001$). Neutrophil infiltration was significantly less among the parasitic group in comparison to the non-parasitic group (10.8% Vs. 92.5%, $p < 0.001$). Microscopic examination reveals acute inflammation of the appendix in 10 cases with *E. vermicularis,* in 5 cases with *A. lumbricoides*, and in 4 cases with *S. mansoni* with significant eosinophil infiltrates.

Table 4: Distribution of the histopathological results of appendicitis.

Histopathologic results	Appendicitis with parasitic infections N= 37	Appendicitis without parasitic infections N= 1328	p
Non-complicated	23 (62.2%)	43 (3.2%)	**0.001**
Acute catarrhal inflammation	5 (13.5%)	287 (21.6%)	**0.03**
Acute suppurative appendicitis	6 (16.2%)	871 (65.6%)	**0.001**
Gangrenous appendicitis	2 (5.4%)	109 (8.2%)	0.06
Gangrenous appendicitis with perforation	1 (2.7%).	18 (1.4%)	**0.03**
Neutrophil infiltration	4 (10.8%)	1228 (92.5%)	**0.001**
Eosinophil infiltration	33 (89.2%)	0 (0%)	**0.001**

N, number; number (%) for qualitative variables

DISCUSSION

Parasitic infections are among the possible causes of appendicitis and should be kept in mind during differential diagnosis. Acute appendicitis is frequent in tropical areas where intestinal parasite infections are common and its precise cause is unknown (Addiss *et al.*, 1991; Okoli *et al.,* 2008). The precise role of parasitic infections in acute appendicitis is still debated because the vast majority of parasitic infections do not result in appendicitis, and parasites are frequently recovered from surgical specimens of bowel that had been resected for reasons other than appendicitis or primary bowel inflammation in some parts of the world (Guzmán-Valdivia, 2006; da Silva, 2007). Therefore, the present study aimed to investigate the prevalence, clinical presentation, and outcomes of parasitic infections in acute appendicitis in an attempt to avoid unnecessary surgery by early detecting and treating parasitic infections, and better-managing patients during and after surgery.

The current study found that parasitic infections were identified in 2.7% of appendectomy specimens. This prevalence is consistent with that of Gupta *et al.* (1989), higher than that of Karatepe *et al.* (2009), and lower than that of Dorfman *et al.* (2003). This wide range of prevalence of parasitic appendicitis is likely due to parasite variations, endemicity, demographic variables, and histologic examination technique discrepancies (Aydin, 2007; Akbulut *et al.*, 2011).

The presence of parasitic infections in the specimens may cause acute appendicitis by blocking the lumen

with parasites or secondary inflammation by the presence of the parasite and/or its ova in the lumen (Addiss *et al.,* 1991; Okoli *et al.,* 2008).

Intestinal *Enterobius vermicularis* infections are the most frequent helminthic infections, affecting up to 200 million people worldwide and *Enterobius vermicularis* infections can mimic acute appendicitis (Chitnis *et al.*, 2020; Sousa *et al.*, 2021). In the present study, the most often reported parasite associated with acute appendicitis was *Enterobius vermicularis*, which was found in 21 (56.8%) of the specimens with parasitic infections and all patients had no mixed parasitic infections. Microscopic examination of *Enterobius vermicularis* specimens revealed acute inflammation in 10 (47.6%) specimens only. This finding is consistent with previous research done by Chitnis *et al.* (2020).

The reported prevalences of *Enterobius vermicularis* in appendectomy specimens of patients with acute appendicitis ranged from 0.2% to 41.8%, with inflammation rates in appendices infected with *Enterobius vermicularis* ranging from 13% to 37% (Marudanayagam, *et al.*, 2006; Aydin, 2007; Wani *et al.,* 2010; Alshihmani, 2022). In the study by Zakaria *et al.* (2013) where they included 51,815 appendectomy cases, 2308 cases were determined to have *Enterobius vermicularis* infections, and findings of inflammation were found in only 12% of them.

It is unclear whether *Enterobius vermicularis* causes appendiceal colic rather than luminal obstruction and real appendicitis, or whether female worm ova release causes mural inflammation. Following appendectomy, patients with *Enterobius vermicularis* infection were given a single oral dosage of 100 mg mebendazole, which was repeated 7-10 days later because appendectomy treats only the consequence and not the cause of the disease.

Infections with *Ascaris lumbricoides* cause about 20,000 deaths every year. The infections might be asymptomatic. However, extra-intestinal ascariasis is likely to cause more severe conditions such as acute appendicitis, acute pancreatitis, or abscess in the liver. Wandering *Ascaris lumbricoides* may infiltrate the vermiform appendix and remain silent or induce pathology (Chamisa, 2009).

In the present study, the *Ascaris lumbricoides* were identified in 9 (24.3%) specimens with parasitic infections, and there were no mixed parasitic infections in any of the patients. Microscopic examination of *Ascaris lumbricoides* specimens revealed acute inflammation in 5 specimens only. This finding is consistent with the findings of previous studies carried out by Karatepe *et al.* (2009) and Chamisa (2009). However, a higher prevalence was reported by Dorfman *et al.* (2003).

Acute Appendicitis associated with *Ascaris lumbricoides* is most likely caused by a high intestinal worm load; multiple appendiceal obstructions and inflammation cases have been reported. However, the presence of migratory *Ascaris lumbricoides* in the vermiform appendix is not uncommon and usually goes unnoticed in most patients. As a result, appendicitis-related *Ascaris lumbricoides* migration into the appendix is still controversial because the symptoms of this migration may mimic appendicitis but seldom induce it (Gupta, *et al.* 1989; Sforza, *et al.* 2011).

Schistosomiasis is considered an endemic disease in several locations, including the Arab peninsula (Lotfy *et al.* 2010). In endemic locations, schistosomiasis seldom causes appendicitis. The current study showed that 7 (18.9%) cases of acute appendicitis with detected schistosomiasis infections and acute appendiceal inflammation with significant eosinophil infiltrates were reported in 4 cases only. According to a systematic review of nearly 35,000 individuals, the total prevalence of schistosomiasis among acute appendicitis patients was 1.31% (Zacarias, *et al.,* 2021), while Hasan *et al.*

(2023) reported a 1.07 % prevalence in patients with acute appendicitis in Egypt.

The pathophysiology of schistosomiasis-related acute appendicitis is uncertain. The most frequent theory is that eggs in the appendix wall cause inflammation, which leads to fibrosis and constriction of the appendiceal lumen. Other hypotheses include *Schistosoma* egg emboli producing ischemia, and granulomatous inflammation of the peri-appendicular intestine, causing fibrosis and disruption of the intestinal wall leading to obstruction of the appendix and acute appendicitis (Badmos, *et al.*, 2006; Ahmed, *et al.*, 2014; Li, *et al.*, 2023). The main lines of treatment for schistosomiasis-related acute appendicitis are appendectomy and praziquantel therapy (40 mg/kg administered as a single oral dosage) (Doudier, *et al.*, 2004).

Parasites in resected appendiceal specimens have been reported to be incidental observations that accompany a non-inflamed appendix. This observation is consistent with our findings which showed that the non-complicated appendix was significantly more common in cases associated with parasitic infections compared to cases without parasitic infections. These findings were consistent with Karatepe et al. (2009). The high prevalence of non-complicated appendix in appendicitis with parasitic infections may be related to intestinal parasites that can create symptoms that resemble acute appendicitis.

In the current study, histopathology examination of the parasitic appendix revealed that eosinophilic infiltration was seen microscopically in 89.2% of parasitic appendicitis cases compared to cases without parasitic infections. This coincided with what had been reported by Zielke, *et al.* (2001) that the parasitic appendices had demonstrated transmural eosinophilic inflammation, with a granulomatous reaction to ova.

Appendicitis is diagnosed by the characteristic symptoms of anorexia, right iliac fossa pain, peritonitis, and increased white blood cells. However, 30% of patients with proven appendicitis had uncommon symptoms, while 30% of patients with probable appendicitis were diagnosed with a different diagnosis (Hasan, *et al.*, 2023). In the present study in acute appendicitis with parasitic infections, 80% of cases showed nausea, 78.3% showed periumbilical pain, and eosinophilia in 62.2%.

The current study confirms the atypical presentation of appendicitis with parasitic infections compared to appendicitis without parasitic infections. History of intestinal parasitic infection symptoms is also a non-reliable stone for pre-surgical diagnosis of the possibility of acute parasitic appendicitis because the total number of worms in the gastrointestinal tract is related to the degree of intestinal tract sickness and the severity (Aydin, 2007). As a result, the clinical diagnosis is not always reliable as appendiceal colic is caused by a parasitic infection, and the final diagnosis of acute appendicitis is only made based on histopathological examination (Alshihmani, 2022).

Abdominal sonography and computed tomography (CT) scans may be utilized to aid in the diagnosis of acute appendicitis associated with parasitic infections. In the present work, abdominal ultrasonography had low sensitivity and specificity; 86% (from 75 - 92%), in appendicitis patients with parasitic infections compared to other research (Zielke, *et al.*, 2001) which reported higher sensitivity and specificity 96% (from 94 - 100%). One possibility for the disparity of these results is that the ultrasonography was performed by a junior radiologist. We believe that ultrasonography should be conducted by an expert radiologist and should not be used to replace clinical judgment in the diagnosis of acute appendicitis with parasite infections.

Therefore, a final diagnosis

should be established with a histopathological evaluation of all three parasites, because stool and urine microscopy for ova were not sensitive as the shedding of parasites may be intermittent in the stool. Multiple stool samples should be collected at different times. Examining the stool in the case of *Enterobius vermicularis* is limited because worms and eggs are not generally passed in the stool (Sah, *et al.*, 2006).

The current study showed that 24.3% of patients with appendicitis with parasitic infections presented with delays compared to appendicitis without parasitic infections. The main cause for the delay is the lack of disease awareness and atypical presentation.

We assessed the postoperative outcomes in the 30-day following appendectomy as we did not have any long-term data on follow-up. No reported mortality in all studied cases. However, the total complication rate among acute appendicitis with parasitic infections was 13.5% which was significantly higher compared to the complication rate that occurred with acute appendicitis without parasitic infections (4.1%), with a longer hospital stay. The most frequent complication was wound sepsis (8.1%) followed by perforation and pelvic collection (2.7% each). The reasons for higher complications among appendicitis with parasitic infections may be related to atypical presentation and delayed diagnosis, which resulted in delayed proper interventions and a higher rate of complications.

In the present work, all patients with confirmed parasitic appendicitis received appropriate anti-parasitic drugs in addition to appendectomy to eradicate the parasite and prevent its sequelae (Sforza, *et al.*, 2011; Imamura, *et al.*, 2019; Alshihmani, 2022; Li, *et al.*, 2023; Shiihara, *et al.*, 2023).

In summary, despite the low prevalence of parasitic infections in appendectomy specimens, surgeons should always include parasitic infections in the differential diagnosis of acute appendicitis as a rare cause and its implications on further treatment to minimize delayed diagnosis and complications. We firmly recommend histopathological examination of all appendectomy specimens, regardless of whether they are macroscopically normal. Following appendectomy, the proper antiparasitic medication should be administered to save patients from morbidity and mortality due to unnecessary surgical procedures.

Conclusions

The current study demonstrated that acute parasitic infections are one of the infectious agents that can be identified in the resected appendix and may increase the risk of appendicitis. This finding emphasizes the importance of considering the neglected role of parasites in acute appendicitis. As a result, early detection and treatment of parasites are recommended for complete eradication.

Ethical Statement: Ethical approval was taken from the Research Ethics Committee of Al-Baha College of Medicine number REC/MIC/BU-FM/2023/46.

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ARABIC SUMMARY

الالتهابات الطفيلية كسبب مهمل لالتهاب الزائدة الدودية الحاد: قيمة المعالجة المرضية الروتينية لعينات استئصال الزائدة الدودية

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دور العدوى الطفيلية في التهاب الزائدة الدودية الحاد لا يزال محل جدل. نحن نهدف إلى دراسة دور الالتهابات الطفيلية في التهاب الزائدة الدودية الحاد كعامل خطر مهمل في محاولة للتشخيص المبكر والعلاج.

شملت هذه الدراسة بأثر رجعي 1365 مريضا خضعوا لعملية استئصال الزائدة الدودية. تم الحصول على البيانات الديموغرافية والأعراض والمضاعفات والتحاليل والتقارير المرضية من سجلات المرضى. تم تقسيم المرضى إلى مجموعتين، المجموعة الأولى (37 مريضا)، وكانت العدوى الطفيلية موجودة، والمجموعة الثانية (1328 مريضا) مع غياب العدوى الطفيلية.

كان معدل انتشار التهاب الزائدة الدودية الطفيلي الحاد 2.7٪. كان متوسط الفئة العمرية للمرضى الذين يعانون من الالتهابات الطفيلية الزائدة الدودية 23.86 ± 10.1 سنة مع نسبة الذكور إلى الإناث 1.6: 1. وكانت الطفيليات المكتشفة هي 21 (56.8%) الدودية الدبوسية، 9 (24.3%) الصَفريَ الخراطيني ، و 7 (18.9%) البلهارسيا المانسونية.

كشف الفحص النسيجي المرضي لالتهاب الزائدة الدودية الحاد مع الالتهابات الطفيلية أن النسيج المرضي ليس به مضاعفات في 62.2% من العينات، والتهاب نزفي حاد في 13.5% من العينات، والتهاب الزائدة الدودية القيحي الحاد في 16.2%، والتهاب الزائدة الدودية الغنغريني الحاد في 5.4% من العينات، ومع الإصابة بداء البلهارسيات كان هناك التهاب الزائدة الدودية الغنغريني الحاد مع الثقب في 2.7% من العينات. كانت الأعراض الشائعة في التهاب الزائدة الدودية الحاد المصحوب بالعدوى الطفيلية هي الغثيان بنسبة 86.5%، والألم حول السرة بنسبة 78.3%. وكانت المضاعفات شائعة بشكل ملحوظ بين مرضى التهاب الزائدة الدودية الحاد المصابين بالعدوى الطفيلية (13.5%) مقارنة مع أولئك الذين لا يعانون من العدوى الطفيلية (4.1%) (قيمة الاحتمال = 0.006). لم يتم الإبلاغ عن وفيات بين الحالات المدروسة.

أظهرت الدراسة الحالية أن العدوى الطفيلية الحادة هي أحد العوامل المعدية التي قد تزيد من خطر التهاب الزائدة الدودية ويمكن تحديدها بعد العملية الجراحية في الزائدة الدودية المستأصلة. تؤكد هذه النتائج على أهمية النظر في الدور المهمل للطفيليات في التهاب الزائدة الدودية الحاد. ونتيجة لذلك، يوصى بالكشف المبكر عن الطفيليات وعلاجها من أجل القضاء التام على هذه الأنواع من العدوى.