Original Article

Role of Ultrasonography in the Diagnosis of Chronic Appendicitis: An Observational Study of 400 Cases

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Abstract

Background: Chronic appendicitis is an uncommon clinical entity. Unlike acute appendicitis, the presence of nonspecific clinical features makes it a challenging diagnosis. Imaging modalities such as ultrasonography and computed tomography (CT) scans aid in the diagnosis of chronic appendicitis. CT scan has been widely described as the investigation of choice in previous studies. However, ultrasonography of the abdomen is a readily available and cheap alternative which provides comparable results and protects from radiation hazards. The aim of this study was to identify the core imaging features of chronic appendicitis on ultrasonography, their correlation with histopathology findings and to establish the most sensitive parameters for radiological diagnosis of chronic appendicitis. **Methods:** This was an observational research study which employed a descriptive study design. All patients suffering from chronic/recurrent abdominal pain in the epigastric, periumbilical region or right lower quadrant were included in the study. The patients were subjected to history taking and clinical examination. Ultrasonography was performed by graded compression technique with high-frequency linear transducer. The specimens of the patients undergoing open or laparoscopic appendectomy were sent for histopathology. The preoperative ultrasonography diagnosis was confirmed on histopathology examination. **Results:** Based on the statistical analysis of various major and minor criteria that were described in this study, the presence of localized pain in the right iliac fossa coupled with the ultrasonography features of irregularity of appendiceal lumen (sensitivity = 84.2%) and loss of wall stratification (sensitivity = 96.5%), showed a combined sensitivity of more than 99%, which were determined to be the most sensitive parameters for clinicoradiological diagnosis of chronic appendicitis. **Conclusion:** Chronic appendicitis has often been misdiagnosed due to atypical symptoms at the time of presentation. Radiological investigations are used in the evaluation of patients with a high degree of clinical suspicion. This article has demonstrated the superiority of ultrasonography over CT scan for imaging of chronic appendicitis due to its advantages such as similar efficacy rates, higher spatial resolution in identifying features of chronic appendicitis, lack of ionizing radiation, cost-effectiveness, and easy availability. However, a definitive diagnosis is achieved by demonstrating evidence of chronic inflammation in the appendectomy specimen at histopathology.

Keywords: Appendectomy, chronic appendicitis, fecolith, histopathology, ultrasonography

Introduction

The vermiform appendix is a blind-ending tubular structure arising from the posteromedial wall of the cecum. While the base of the appendix is fixed in position, the anatomical location of the appendix is variable depending upon its tip. The various positions described are retrocecal, postileal, preileal, and pelvic.[1] Different positions of the appendix lead to variable clinical presentations in case of inflammation of the appendix.[2] Acute appendicitis is one of the most commonly encountered emergencies in surgical practice. The etiopathogenesis, pathophysiology, as well as diagnostic criteria for acute appendicitis, are well-defined. The term chronic appendicitis is difficult to characterize due to the absence of classical clinical signs and symptoms observed during the acute inflammatory process of appendicitis.[3] Chronic appendicitis was first described by Crymble and Forsythe in 1949.[4] It is the result of long-standing inflammation and fibrosis of the appendix which occurs secondary to partial obstruction of the appendiceal lumen and presents clinically as

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Abbreviations

USG	Ultrasonography
CT scan	Computed tomography scan
HPE	Histopathology examination
RIF	Right iliac fossa

chronic abdominal pain. In patients with long-standing history of right lower quadrant pain with no alternate diagnosis to explain the symptoms, surgical consultation should be sought as appendectomy remains the mainstay of treatment with most patients experiencing complete resolution of symptoms. Radiological investigations such as ultrasonography and computed tomography (CT) scans are often sought in clinically suspicious cases. While past literature on chronic appendicitis mainly describes the utility of CT scan of the abdomen as the preferred imaging modality, this article provides insight into the role of ultrasonography of the abdomen as a reliable means for radiological diagnosis of chronic appendicitis. At the hands of an experienced radiologist, ultrasonography has an almost similar rate of efficacy in the diagnosis of this condition compared to CT scan and has added advantages in terms of no exposure to ionizing radiation, higher spatial resolution, easy availability, and cost considerations. Ultrasonography may also aid in the visualization of noncalcified fecolith as the culprit for chronic inflammation of the appendix which may well be missed on CT scan examination. However, a definitive diagnosis of chronic appendicitis is established by means of histological analysis of appendectomy specimens. It is often a challenging diagnosis due to wide variety of differential diagnoses which include other gastrointestinal as well as genitourinary pathologies.Failure to diagnose this entity may result in complications such as appendiceal perforation, intra-abdominal infection/abscess, peritonitis, and bowel obstruction.[5] The aim of this study was to identify the core imaging features of chronic appendicitis on ultrasonography, their correlation with histopathology and to establish the most sensitive parameters for the radiological diagnosis of chronic appendicitis.

Materials and Methods

Study design

The research employed a descriptive study design. It was an observational research study with no control group. The study was performed in a tertiary care hospital over 18 months. The study was conducted in accordance with the declaration of Helsinki and was approved by the Institutional Ethics Committee, Government Medical College, Miraj (vide letter no: GMCM/IEC/C-24/2022; approval dated 17/09/2022).

Study population

This was a study comprising 400 patients. Before inclusion, the patients were explained about the study in vernacular language. Written and informed consent was obtained from all participants included in the study. The age of patients in the study population ranges from 18 years to 65 years.

Inclusion criteria

1. Patients suffering from chronic abdominal pain in the epigastric, periumbilical region or right lower quadrant
2. Patients between the age range of 18 and 65 years
3. Patients were willing to give written and informed consent.

Exclusion criteria

1. Patients not willing to give written consent for inclusion in the study
2. Patients with postappendectomy status
3. Patients diagnosed with complications such as appendiceal perforation and abscess/phlegmon formation.

Data collection methods

The patients were subjected to detailed clinical history taking and clinical examination. All the patients were examined in nil per oral status. All the patients suffering from chronic abdominal pain in the epigastric, periumbilical region or right lower quadrant were included in the study. Ultrasonography examination of these patients was performed on "Canon Aplio A" ultrasound equipment by graded compression technique using a high frequency 7.5 MHz linear transducer. The appearance of the wall of the appendix, appendiceal lumen caliber, presence or absence of fecoliths, and mesenteric lymphadenopathy was documented. The patients underwent open or laparoscopic appendectomy and the specimen was sent for histopathological examination. The preoperative ultrasonography diagnosis was confirmed on histopathology examination.

Statistical analysis

Data were collected in predesigned Microsoft Excel spreadsheet. Demographic data of the study population was analyzed to determine the distribution of age, gender, and area of residence among cases using descriptive statistical measures such as mean and standard deviation. Subsequently, the data pertaining to clinical signs and ultrasonography features of chronic appendicitis were tabulated in the form of frequency tables and the sensitivity of findings amongst the study population was computed using Epitools epidemiological calculator software.

Results

Demographic analysis

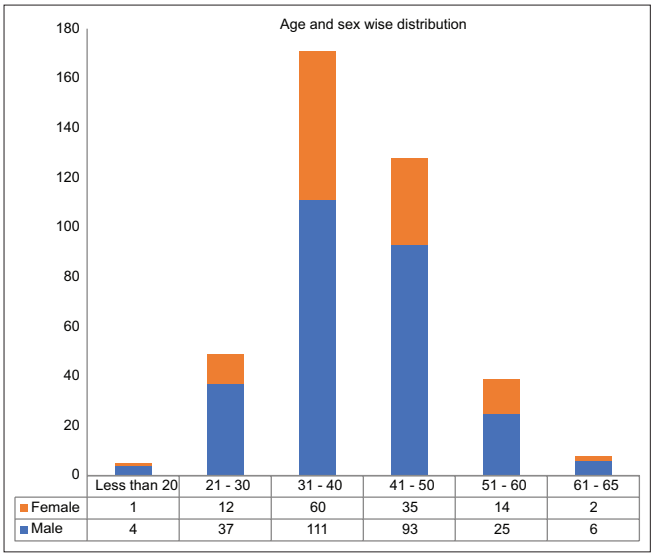
In this study, the sample population consisted of 400 patients. Table 1 depicts the demographic characteristics of the study population. The mean age was determined to be 38 years with a standard deviation of ±5 years. The data on sex-wise distribution depicts definite male preponderance. The study revealed 276 affected males as compared to 124 females. Affected individuals residing in urban areas contributed to 72% of cases as compared to rural areas showing 28% of caseload.

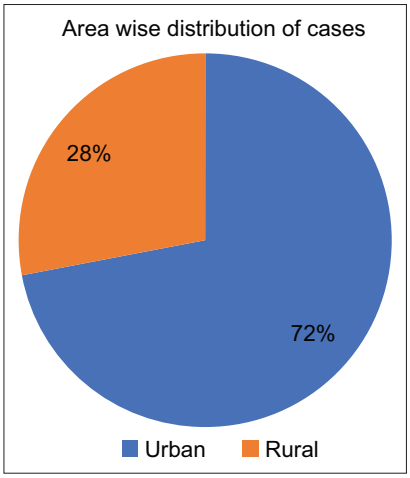
Clinical and ultrasonography features

Based on the clinical and ultrasound examination, various clinical signs and ultrasonography features were identified

Table 1: Demographic characteristics of the study population

Demographic characteristics	Frequency (%)
Age range (in years)	
<20	5 (1.25)
21–30	49 (12.25)
31–40	171 (42.75)
41–50	128 (32)
51–60	39 (9.75)
61–65	8 (2)
Sex/gender	
Male	276 (69)
Female	124 (31)
Area of residence	
Urban	288 (72)
Rural	112 (28)





for the diagnosis of chronic appendicitis. These findings along with the frequency of their occurrence in the study population are shown in Table 2.

Table 2: The ultrasound features and clinical signs in chronic appendicitis along with their frequency of occurrence in study population

Imaging feature/clinical sign	Frequency (*n*)	Sensitivity (*n*/400) (%)
Irregularity of appendiceal lumen	337	84.2
Loss of wall stratification	386	96.5
Presence of fecolith within appendiceal lumen	266	66.5
Mesenteric lymph nodes in RIF	288	72
Absent peristalsis in appendix	78	19.5
Localized pain in RIF	223	55.7
Probe tenderness in RIF	172	43.2
Pain in periumbilical region	127	31.7
Chronic epigastric pain not relieved with antacids	50	12.6

RIF: Right iliac fossa

They were classified into major criteria consisting of the key ultrasonography features and minor criteria which included clinical signs and ancillary radiological findings.

Major criteria

1. Loss of wall stratification (sensitivity = 96.5%)
2. Irregularity of appendiceal lumen (sensitivity = 84.2%)
3. Presence of fecolith within the appendiceal lumen
4. Mesenteric lymph nodes in the right iliac fossa (RIF).

Minor criteria

1. Localized pain in RIF
2. Probe tenderness in RIF
3. Pain in the periumbilical region
4. Chronic epigastric pain not relieved with antacids and antibiotics
5. Absent peristalsis in the appendix.

The data in Table 3 presents various combinations of the major and minor criteria along with their combined sensitivity. Based on statistical analysis, it was observed that localized pain in RIF along with the ultrasound features of irregularity of appendiceal lumen and loss of wall stratification showed a combined sensitivity of >99% were the most sensitive parameters for the clinicoradiological diagnosis of chronic appendicitis.

Histopathology

1. Appendiceal lumen obliterated by inflammatory exudate/fecolith with submucosal fibrosis and mucosal ulceration.
2. The wall of the appendix shows infiltration by mononuclear cells
3. The serosa shows congestive blood vessels.

Discussion

Chronic appendicitis has a reported incidence rate of <1.5%.[6] It may be confused with recurrent/relapsing appendicitis which includes episodic attacks of right lower quadrant pain leading

Table 3: The combined sensitivity of various major and minor criteria described in this study

Clinical sign + ultrasound features	Combined sensitivity (%)
Localized pain in RIF + loss of wall stratification	98.4
Localized pain in RIF + irregularity of appendiceal lumen	93.1
Localized pain in RIF + mesenteric lymph nodes in RIF	87.6
Localized pain in RIF + presence of fecolith	85.1
Localized pain in RIF + absent peristalsis in the appendix	64.3
Probe tenderness in RIF + irregularity of appendiceal lumen	91
Probe tenderness in RIF + loss of wall stratification	97.9
Probe tenderness in RIF + mesenteric lymph nodes in RIF	84.1
Probe tenderness in RIF + presence of fecolith	80.9
Probe tenderness in RIF + absent peristalsis in the appendix	54.2
Pain in periumbilical region + mesenteric lymph nodes in RIF	80.8
Pain in periumbilical region + presence of fecolith	77.1
Chronic epigastric pain not relieved with antacids + irregularity of appendiceal lumen	86.1
Chronic epigastric pain not relieved with antacids + mesenteric lymph nodes in RIF	75.5
Localized pain in RIF + loss of wall stratification + irregularity of appendiceal lumen	99.7
Localized pain in RIF + mesenteric lymph nodes in RIF + presence of fecolith	95.8
Probe tenderness in RIF + presence of fecolith + mesenteric lymph nodes in RIF	94.6
Probe tenderness in RIF + presence of fecolith + irregularity of appendiceal lumen	97.2
Pain in periumbilical region + mesenteric lymph nodes in RIF + presence of fecolith	93.5
Chronic epigastric pain not relieved with antacids + mesenteric lymph nodes in RIF + presence of fecolith	91.7

RIF: Right iliac fossa

to appendectomy. However, histopathological examination reveals acute inflammation in the specimen, in contrast to chronic appendicitis which shows chronic inflammatory changes.[7] It is hypothesized that while recurrent appendicitis is a sequela of transient occlusion of the appendiceal lumen or excessive mucin production,[8] chronic appendicitis occurs due to partial but persistent obstruction of the appendiceal lumen, due to fecoliths, lymphadenopathy, or appendiceal folding.[9] It is a challenging diagnosis as patients present with atypical symptoms, in contrast to the classical clinical signs and symptoms associated with acute appendicitis. A wide variety of differential diagnoses may mimic chronic appendicitis. These include diseases of the urogenital tract such as renal or ureteric calculi, pelvic inflammatory disease, and ovarian dermoid.[10,11] Cases resembling chronic inflammatory diseases of the gastrointestinal tract such as Crohn's disease, diverticulitis, intestinal tuberculosis, and mesenteric panniculitis have also been reported in the literature.[12]

Continuous or recurrent low-grade right lower quadrant pain should raise clinical suspicion of chronic appendicitis as a differential diagnosis.[13] Periumbilical pain radiating to the right lower quadrant in appendicitis is attributed to the irritation of the visceral T8–T10 afferent nerve fibers which supply the umbilicus as well as the appendix.[14] The mesoappendix is an appendage of the mesentery containing appendicular vascular supply. The mesentery of the small intestine extending from the duodenojejunal flexure is always continuous with the mesorectum.[15] A mesenteric apex arising in the right mesocolon at the ileocecal junction known as ileocecal mesenteric confluence gives rise to mesoappendix at its posterior surface.[16,17] Thus referred pain from chronic appendicitis occurs at the epigastric region which is unrelieved by antacids and antibiotics.

Radiological investigations are often used in the diagnosis of suspected appendicitis.[18] Ultrasonography is the first-line imaging technique in the case of chronic appendicitis with sensitivity rates ranging from 78% to 93% and specificity rates ranging from 86% to 95%.[19,20] The graded compression technique described by Puylaert is the most widely used technique for visualization of the appendix on ultrasonography.[21] This technique allows the gas-filled bowel loops to be displaced or compressed between the abdominal wall musculature thereby facilitating the visualization of the obstructed appendix which is incompressible. Additional maneuvers such as the application of pressure posteriorly to improve the degree of compression and upward sweeping motion with the transducer are also utilized.[22] The upward pressure helps in displacing the cecum and appendix, especially when the appendix is low-lying or pelvic in position.[23] High-frequency linear transducers with frequency range of 5–9 MHz are widely recommended for visualization of the appendix.[24] On ultrasonography, the normal appendix appears as a compressible tubular blind-ending structure with striated appearance of its walls [Figure 1]. Chronic appendicitis is characterized by a noncompressible, often dilated appendix associated with thickened irregular wall and loss of normal wall stratification [Figure 2]. Other imaging features include fecolith within the appendiceal lumen [Figure 3] and echogenic mesentery surrounding the appendix.[25] A fecolith is defined as a concretion of dry compacted feces which is formed in the intestines or vermiform appendix.[26] Mesenteric lymphadenopathy in RIF may be associated with chronic appendiceal inflammation [Figure 4].

CT scan of the abdomen is the imaging investigation with higher sensitivity rates ranging from 90% to 98% and specificity of 91%–98%.[27] Although CT scan has higher sensitivity for visualization of the appendix, features of chronic appendicitis on CT scan which have been described by Rao *et al*.[28] includes fat stranding in pericecal tissue, appendiceal dilatation, wall thickening, calcified fecolith, and mesenteric lymphadenopathy. These features are similar to those in acute appendicitis and thus cannot differentiate between acute and chronic inflammation. Meanwhile

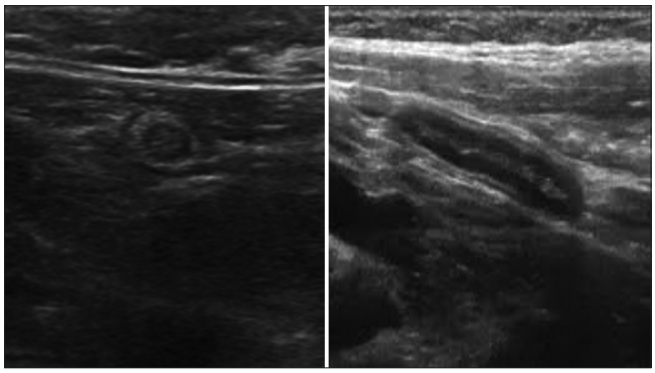


Figure 1: Appearance of normal appendix on transabdominal ultrasonography scan, as seen in axial view (left) and longitudinal view (right). Note the stratified appearance of the wall as seen in a normal appendix on ultrasound

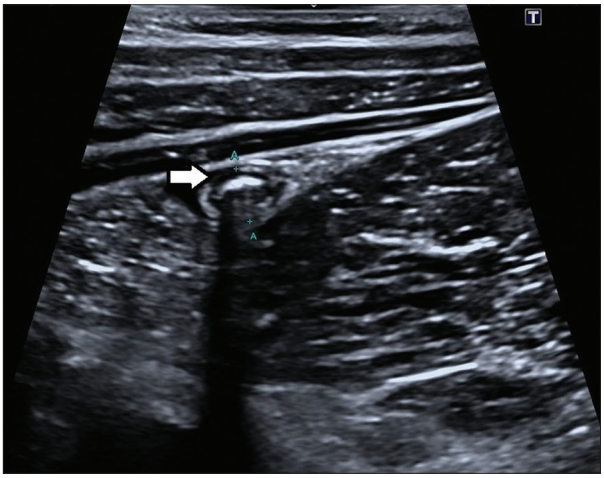


Figure 3: The presence of fecolith (white arrow) within the appendiceal lumen which appears as a hyperechoic linear structure with postacoustic shadowing

ultrasonography, due to its higher spatial resolution, aids in identifying features of chronic inflammation such as irregularity of appendiceal lumen and loss of wall stratification which are specific for chronic appendiceal inflammation. The presence of noncalcified fecolith [Figure 5] as the causative factor for chronic appendicitis which can be visualized on ultrasound may be missed on CT scan. Other advantages of ultrasonography also include the prevention of exposure to ionizing radiation, cheap cost, and easy and ready availability. However, ultrasonography is an operator-dependent modality and has limitations like interobserver variability depending on the expertise of the radiologist or sonologist and failure to visualize the appendix in obese patients or patients with excess abdominal fat.[29] CT scan still remains the investigation of choice in these patients.

Appendectomy is the mainstay of treatment of chronic appendicitis [Figures 6 and 7]. Most patients experience complete resolution of symptoms following surgery.[30] Unlike acute appendicitis, it is not a dire surgical emergency. However, in case of failure to diagnose, the patient may land up with

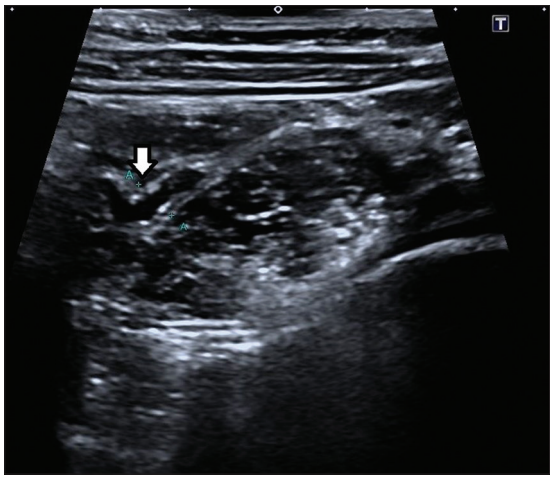


Figure 2: Loss of stratified appearance of the appendiceal wall is noted (white arrow). Also, note the irregularity of appendiceal lumen caliber as seen in the image

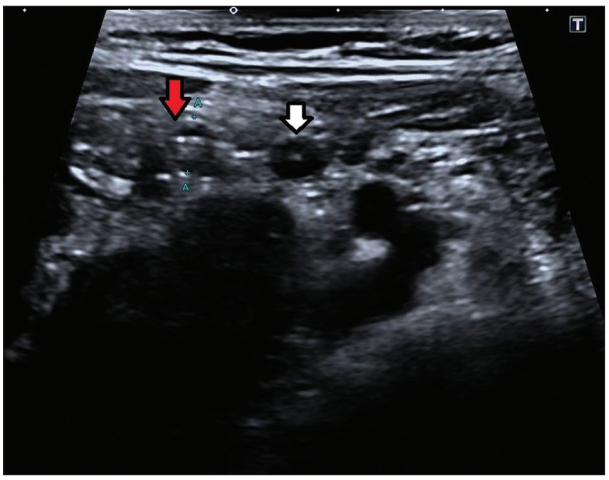


Figure 4: The presence of enlarged mesenteric lymph node (white arrow) was noted in the right iliac fossa, seen adjacent to a chronically inflamed appendix (red arrow)

complications like perforation abscess/phlegmon or peritonitis, especially in patients with intraluminal fecoliths[31] [Figure 8].

Chronic appendicitis is often diagnosed by the pathologist at histopathological examination of the appendectomy specimen.[32] It has been reported by Stroh *et al*. that the histological diagnosis of chronic appendicitis has increased following an increase in the number of diagnostic laparoscopy procedures and laparoscopic appendectomies.[33] The histopathological diagnosis is based on evidence of chronic inflammation causing fibrosis, obliteration of the appendiceal lumen, and infiltration of mononuclear cells into wall of the appendix [Figure 9]. The luminal obstruction may be due to intraluminal exudates or fecolith within the appendiceal lumen [Figure 10]. Mussack *et al*.[34] performed a study wherein the appendectomy specimen was analyzed macroscopically by the surgeon and histopathological examination was performed by two independent pathologists. The macroscopic

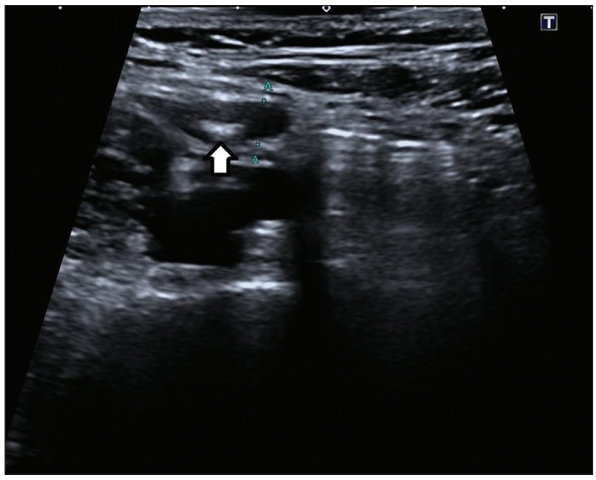


Figure 5: Presence of noncalcified fecolith (white arrow) within the appendiceal lumen. Noncalcified fecolith may be missed on computed tomography scan

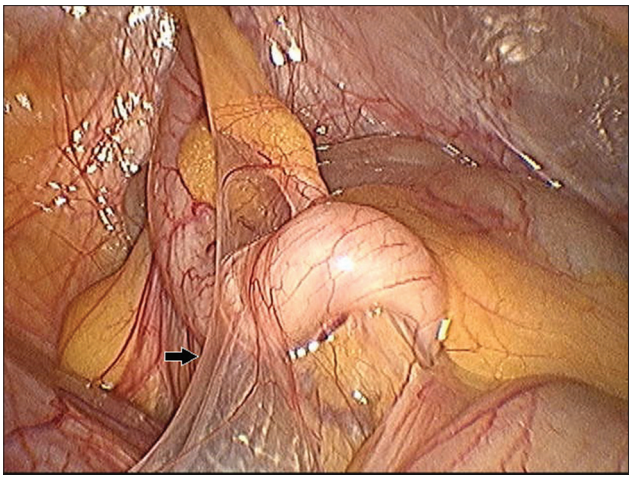


Figure 6: Inflamed appendix is seen intraoperatively during laparoscopic appendectomy. Multiple intraperitoneal adhesions are noted due to the chronic inflammatory process (black arrow)

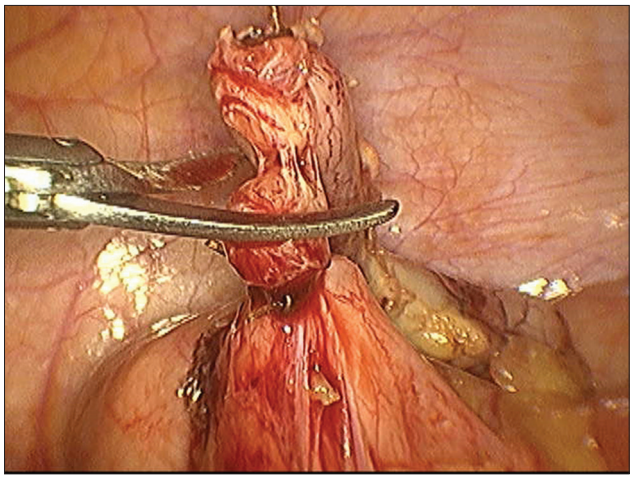


Figure 7: Cut section of the appendix intraoperatively reveals obliteration of the appendiceal lumen due to chronic inflammation with subsequent fibrosis

Figure 8: Appendectomy specimen reveals irregularity of the appendiceal lumen with focal dilatation of the appendix (black arrow) likely due to impacted fecolith with narrowing of lumen caliber distal to it

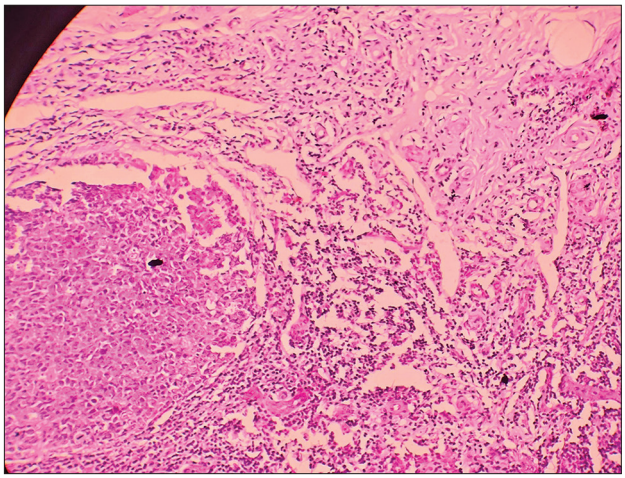


Figure 9: Histological evidence of submucosal fibrosis with eosinophilic infiltration was noted within appendectomy specimen

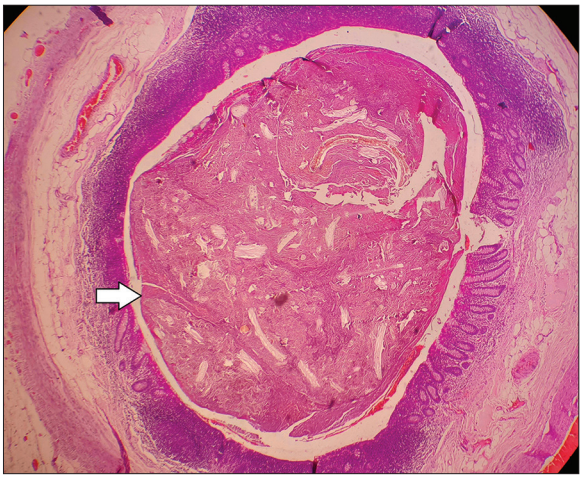


Figure 10: Cut-section of the appendix at histopathology showing the presence of intraluminal fecolith (white arrow)

examination by the surgeon intraoperatively was reported to have a high sensitivity (~77.8%) and specificity (~93.5%) for subsequent diagnosis of chronic appendicitis at histopathology.

Mattei *et al*.[35] described a case series of patients undergoing appendectomy for chronic and recurrent appendicitis. The study formulated diagnostic criteria for chronic appendicitis which were as follows:

- Persistent/continuous right lower quadrant pain for 3 weeks or more
- Lack of alternative diagnosis to explain symptoms
- Presence of chronic inflammation in the appendectomy specimen at histopathology
- Complete resolution of symptoms postappendectomy.

Conclusion

Chronic appendicitis has often been misdiagnosed due to atypical symptoms at the time of presentation which mimics other pathologies of the gastrointestinal and genitourinary tract. Radiological imaging modalities are used in the evaluation of patients with high degree of clinical suspicion. This article has demonstrated the superiority of ultrasonography over CT scan for imaging of chronic appendicitis due to its advantages such as similar efficacy rates, higher spatial resolution, cost-effectiveness, easy availability, and lack of ionizing radiation. Limitations of ultrasonography such as operator dependability, interobserver variations, and inability to visualize the appendix in excessively obese patients warrant the use of CT scan. However, the demonstration of evidence of chronic inflammation in the appendectomy specimen at histopathology provides definitive diagnosis.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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