

Clinical, Ultrasound and Surgical Study of Acute Appendicitis at the Kalale Clinic in Bamako

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Abstract

Introduction: Acute appendicitis is the acute inflammation of the ileocecal appendix. It is the most frequent abdominal surgical emergency. The aim of our study was to investigate the clinical, ultrasound, and surgical aspects of acute appendicitis. **Methodology:** This was a prospective, descriptive study conducted over 12 months on 51 cases in the radiology and medical imaging department of the KALALE Medical Clinic in Bamako. The parameters studied included sociodemographic, clinical, ultrasound, and therapeutic data. **Results:** The overall incidence was 0.425% of cases. The most represented age group was between 15 and 25 years. Males were the most represented sex, accounting for 66% of cases, with a male-to-female ratio of **1.94**. Right iliac fossa pain was the most frequently observed clinical sign, present in 35.3% of cases. On ultrasound, the appendix was visible in 100% of cases, with a mean antero-posterior diameter of 10.237 mm and a mean wall thickness of 3.714 mm. The most sensitive indirect signs were appendiceal incompressibility and infiltration of the peri-appendiceal fat, which was found in 100% of patients. Ultrasound had diagnosed simple acute appendicitis in 42 patients, appendiceal abscess in 6 patients, peritonitis in 2 patients, and appendiceal phlegmon in 1 patient. Following surgical exploration, acute appendicitis was found in 37 patients, appendiceal abscess in 10 cases, appendiceal peritonitis in 2 patients, appendiceal phlegmon in 1 patient, and 1 case of tumor. **Conclusion:** Our study confirmed that ultrasound is a high-performing examination with high sensitivity and specificity. Comparison between the ultrasound image and the postoperative findings showed good agreement, particularly for the diagnosis

of complicated forms, thus allowing for better surgical planning.

Keywords

Acute Appendicitis, Ultrasound, Clinical Presentation, Surgical Correlation

1. Introduction

Acute appendicitis is the acute inflammation of the ileocecal appendix. It is the most frequent abdominal surgical emergency [1] [2]. The annual incidence of appendicitis is between 40 and 60 per 10,000 inhabitants in France [3]. This figure is much higher than in other European countries or North America, where it is between 11 and 18 per 10,000 inhabitants [3]. In Australia, the incidence of acute appendicitis is estimated at between 103 and 122 cases per 100,000 inhabitants [4]. In Africa, it accounts for 33% of surgical emergencies in Dakar [5] and 42.3% in Bangui [6]. Studies conducted throughout Mali found incidence rates ranging from 22.36% to 52.17% [7]-[9]. Appendicitis can occur at any age, but it is rare at the extremes of age [10]. Diagnosis is usually based on clinical presentation and laboratory tests [11]. However, it is not always straightforward given the clinicopathological polymorphism of acute appendicitis. This diagnostic difficulty highlights the importance of ultrasound, which allows for a positive diagnosis and the exclusion of many differential diagnoses. Unrecognized or delayed appendicitis can lead to complications and even the patient's death [12]. A recent French multicenter randomized study [13], conducted by six hospital departments, concluded that emergency appendectomy should remain the gold standard for the management of uncomplicated appendicitis. However, these conclusions have been called into question due to the erroneous inclusion in this trial of some patients with complicated appendicitis and also the use of an antibiotic combination that may encounter resistance in some bacteria in this condition [14]. This study, the first of its kind, fills a gap and aims to study the sensitivity and specificity of ultrasound in comparison with data from surgical exploration.

2. Methodology

This was a prospective, descriptive study conducted from April 1, 2024, to March 31, 2025 (a period of 12 months) in the radiology and medical imaging department of the KALALE Medical Clinic in Bamako. The study included all patients referred to the medical imaging department for suspected acute appendicitis. Patients with clinical suspicion of acute appendicitis or its complications who had undergone ultrasound and surgery were included. The equipment used was a General Electric Voluson model with three probes, including a superficial probe (9L-D) and a deep probe (C1-5), which were used for the examinations. The examinations were performed by radiologists and students acting as interns. Data were collected from ultrasound and surgical reports, and patients' clinical

data were recorded on a questionnaire. Data entry was performed using Microsoft Word 2016 and SPSS version 26. We studied sociodemographic data (age, sex, medical history, etc.), clinical signs, direct and indirect ultrasound findings, and complications. Finally, we compared the ultrasound data with those from surgical examinations to evaluate the diagnostic performance of ultrasound. The absolute reference standard is based on histopathological examination combined with intraoperative findings, while abdominal ultrasound serves as an evaluation test. Performance indicators sensitivity, specificity, positive predictive value, and negative predictive value guide clinical decisions regarding surgical management.

Agreement is quantified by the Fleiss or Cohen kappa coefficient (κ). A κ between 0.61 and 0.80 indicates strong agreement, and a κ greater than 0.80 indicates near-perfect agreement. Inter-observer agreement was very high for appendiceal diameter measurement, moderate (moderate agreement, κ between 0.41 and 0.60) for color Doppler hyperemia and periappendiceal fat infiltration. The Ethics Committee of the Faculty of Medicine in Bamako had given its authorization, the informed verbal consent of the patients was obtained and anonymity was preserved.

3. Results

3.1. Socio-Epidemiological Data

Table 1. Distribution of patients by age group.

Age range	Frequency	Percentage
15 - 25 Years	18	35.3
5 - 15 Years	8	15.7
25 - 35 Years	13	25.5
35 - 45 Years	8	15.7
45 Years and older	4	7.8
Total	51	100.0

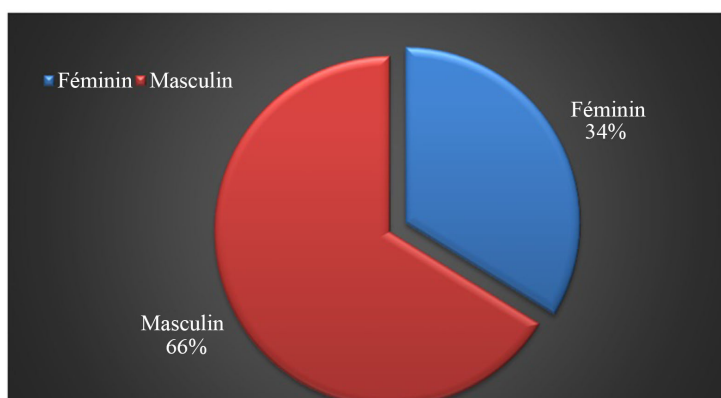


Figure 1. Distribution of patients by sex.

During the study period, 12,000 abdominal and abdominopelvic ultrasounds were performed in the department, and 51 cases of appendicitis were diagnosed, representing a frequency of 0.425% of cases. The most represented age group was between 15 and 25 years (**Table 1**). Males were the most represented sex, at 66%, with a sex ratio of 1.94 (**Figure 1**). Nearly 2% of patients had one or more previous surgical interventions for other pathologies and 2% of patients had one or more drug treatments for chronic pathology. Physicians were the primary prescribers in 68.4% of cases, compared to 31.6% for nurses.

3.2. Clinical Data

Pain in the right iliac fossa was the most frequently observed clinical sign in 35.3% of cases (**Table 2**).

Table 2. Distribution of patients according to clinical data.

Clinical data	Frequency	Percentage
Right lower quadrant pain	18	35.3
Abdominal pain	9	17.6
Diffuse abdominal pain	4	7.8
Abdominal and pelvic pain	4	7.8
Right flank pain	4	7.8
Appendiceal pain	2	3.9
Abdominal pain, vomiting	1	2.0
Abdominal and pelvic pain	1	2.0
Pelvic pain + right flank pain	1	2.0
Pain + fever	1	2.0
Abdominal pain, appendicitis?	1	2.0
Abdominal pain, vomiting	1	2.0
Diffuse abdominal and pelvic pain	1	2.0
Right flank pain	1	2.0
Umbilical region pain	1	2.0
Diffuse epigastric pain	1	2.0
Total	51	100.0

3.3. Ultrasound Data

In our study, 42 of the 51 patients examined tested positive for acute appendicitis on ultrasound. Among the 42 patients who underwent surgery, 4 had recovered from appendiceal abscesses and 1 had a rectosigmoid tumor. The most frequent location of the appendix was mesocecal (72.5% of cases), followed by laterocecal location (21.6% of cases) and retrocecal location (5.9% of cases). We did not observe any subhepatic or pelvic locations. The mean anteroposterior diameter of the appendix was 10.23 mm (range 7 - 18 mm), and the mean wall thickness was 3.71 mm (range 3 - 5 mm). All patients experienced pain at McBurney's point

upon passage of the ultrasound probe, an incompressible appendix, and inflammation of the periappendiceal fat. Appendiceal sclerotherapy was found in 3.9% of cases, and right iliac fossa lymphadenopathy in 25.5% of cases. Color Doppler ultrasound revealed increased abdominal wall hyperemia in 65% of cases. Intra-peritoneal fluid effusion was the most frequently associated sign, occurring in 17.7% of cases. The most common complication detected by ultrasound was appendiceal abscess in 11.8% of cases, followed by peritonitis due to appendiceal perforation in 3.9% of cases and appendiceal phlegmon in 2% of cases. There is a significant correlation between ultrasound findings and surgery. Therefore, ultrasound is a reliable examination for the diagnosis of appendicitis. The sensitivity rate of ultrasound for acute appendicitis was 100%, and the specificity was 64.28%. The positive predictive value was 88.09%, and the negative predictive value was 100%. Ultrasound performance was 97% in acute appendicitis and 95% in complications such as abscesses and peritonitis. However, we observed the limitations of ultrasound in staging (distinguishing between acute appendicitis and abscesses).

3.4. Surgical Data

The surgeons were informed of the ultrasound results in all cases (100% of cases). Patients were operated on the same day between 2 and 6 hours. After surgery, simple acute appendicitis was the most common diagnosis (72.5%), and the most frequent complication was appendiceal abscess (19.6%), followed by peritonitis due to appendiceal perforation (3.9%). Rectosigmoid tumor was found in 2% of cases (**Figures 2-4**).

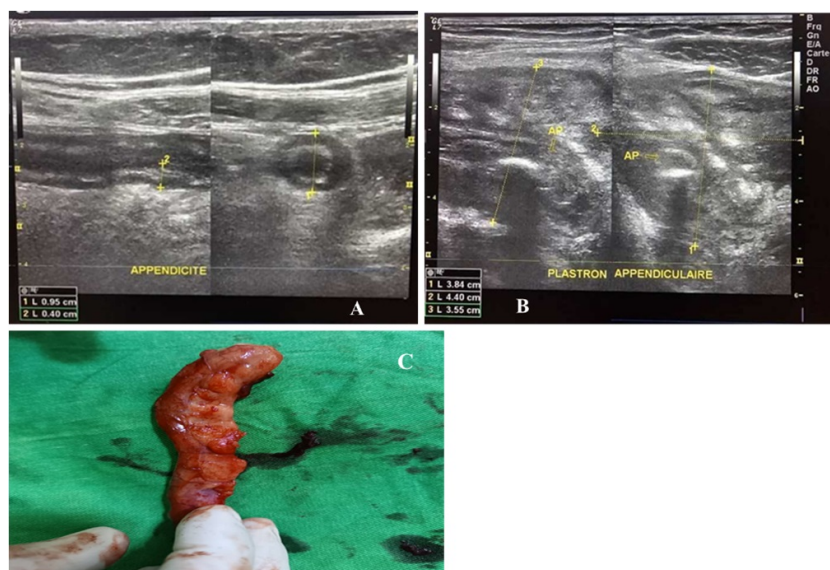


Figure 2. Abdominal ultrasound showing parietal thickening, increased anteroposterior diameter, and infiltration of the periappendicular fat suggestive of acute appendicitis (A), and agglutination of the loops around a thickened appendix with infiltration of the periappendicular fat suggestive of an appendiceal phlegmon (B). Image (C) shows the surgical specimen from the acute appendicitis case after surgery.

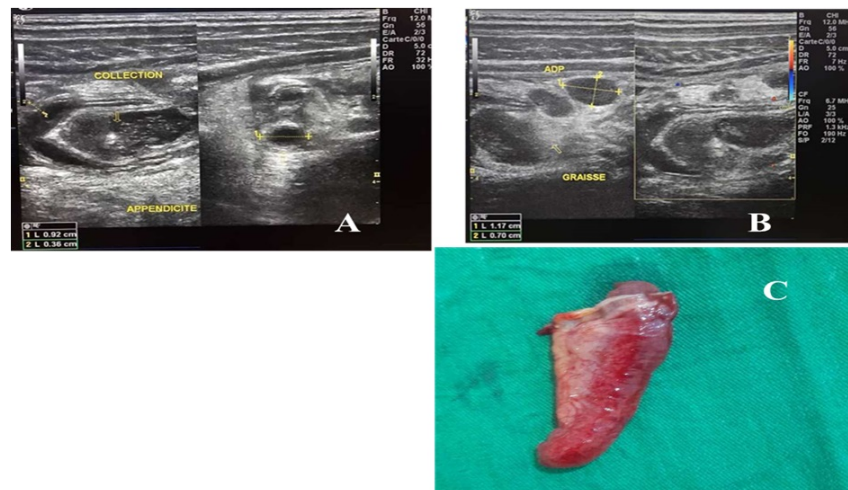


Figure 3. Echographie abdominale en coupes longitudinale (B) et transversale (A) objectivant une collection à contenu liquidien renfermant des fins échos en regard appendicite inflammatoire associé à des adénomégalias coelio-mésentériques: **Abcès appendiculaire**. L'image (C) montre la pièce opératoire de l'abcès appendiculaire après chirurgie.

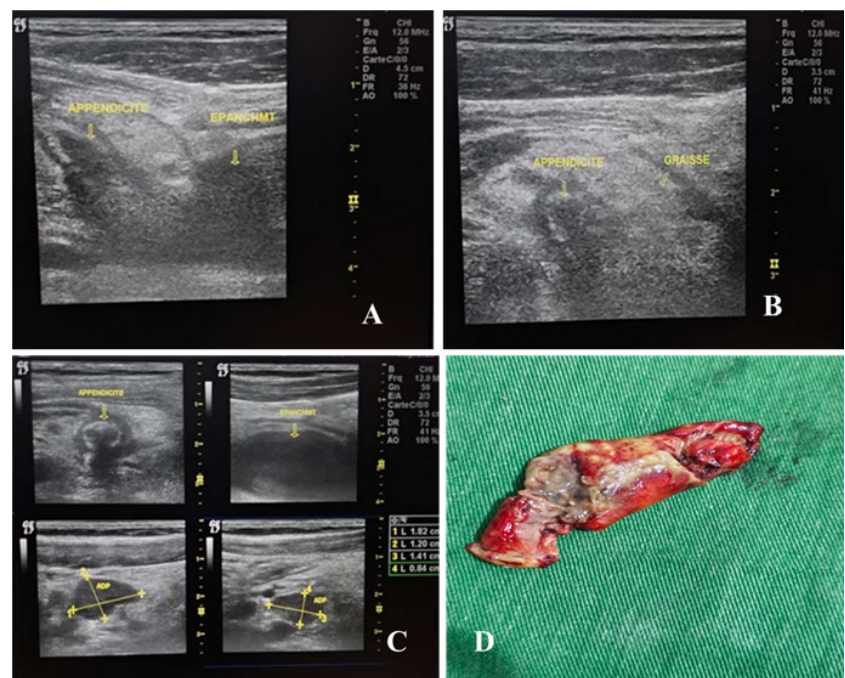


Figure 4. Abdominal ultrasound in transverse and longitudinal sections (A, B and C) highlighting a fluid collection in the RIF containing fine echoes suspended around a thick appendix with parietal rupture associated with celiac-mesenteric lymphadenopathy suggestive of peritonitis on perforation of appendiceal abscess with the photo of the operative specimen of the perforated appendix after surgery (D).

4. Discussion

4.1. Socio-Epidemiological Data

Our study included 51 cases of appendicitis diagnosed by ultrasound and corre-

lated with the surgical appearance in the radiology and medical imaging department of the KALALE clinic, out of 12,000 abdominal and abdominopelvic ultrasounds, representing a prevalence of 0.425% of cases. These results were comparable to those of CHIPPONI J *et al.*, who found 0.6% of cases. [3] The most represented age group was 15 - 25 years, with a mean age of 26.41 years and a range from 6 to 80 years. This mean age was consistent with those reported in the literature [15]-[17], which found mean ages of 24, 25, and 27.08 years, respectively. These findings demonstrate that appendicitis is a condition that occurs much more frequently in young people. In our series, males were the most represented, accounting for 66% of patients, with a male-to-female ratio of 1.94. This is consistent with several studies in the literature reporting a male predominance, with a male-to-female ratio ranging from 1.05 to 3.2 [18]-[21]. Although some authors suspect anatomical and hormonal factors, with an increased risk in men, the exact reasons for this male predominance are not yet clearly explained by science.

4.2. Clinical Data

Pain was present in all our patients and localized to the right iliac fossa in 35.3% of cases. This predominance of pain in the right iliac fossa was also found in the literature [15] [16], with 71.4% and 70% of cases, respectively. This high frequency of pain in the right iliac fossa could be explained by the normal anatomical location of the appendix. According to Simpson, the pain should ideally be located at McBurney's point, which corresponds to the base of the appendix [22]. The most frequent location of the appendix was mesocecal, accounting for 72.5% of cases. A study conducted in Senegal [21] found a result very similar to mine, with 66.66% of cases of appendicitis being mesocecal.

4.3. Ultrasound Data

In our study, the appendix was incompressible in 100% of cases. This sign suggestive of appendicitis on ultrasound was found in the majority of studies, notably in Löfvenberg F and CHINBO [17] [23]; PUYLAERT noted that 89% of patients had an incompressible appendix.

This sign (incompressibility) of the appendix under the influence of the probe in the right iliac fossa (pain at McBurney's point) was the first diagnostic criterion for acute appendicitis on ultrasound [24]. Indeed, it is important to specify that the incompressibility of the appendix strengthens the diagnostic suspicion. The transverse diameter of the appendix was between 7 and 18 mm in 100% of cases. This finding was consistent with the literature [11] [16] [25]-[27]. However, this clinical sign, accepted as relevant for the diagnosis of appendicitis, is not significant outside of a clinical context. The appendiceal wall thickness was between 3 and 5 mm in 100% of cases. A wall thickness greater than 3 mm corresponds to the pathological threshold described [11]. This sign is one of the direct signs of acute appendicitis and reflects mucosal congestion. The increase in wall thickness is largely related to inflammatory processes and can be reduced in cases of ische-

mia. Wall hyperemia was found in 65% of cases in our series. Our results were similar to those of Bergeron E *et al.*, who found parietal hyperemia in 71.72% of their patients [28]. Wall hyperemia is an important criterion in acute appendicitis, but it may be absent in the gangrenous stage [16]. The periappendiceal fat was hyperechoic or infiltrated in 100% of patients in our series. This infiltration was frequently reported in the literature [11] [15] [17] [23] and considered a major criterion in the diagnosis of acute appendicitis. The Kouame study in Ivory Coast revealed a positive predictive value of 95.8% for indirect signs of appendicitis on ultrasound and a sensitivity of 83.9% for the combination of the three indirect signs, which are: hypertrophy of the periappendiceal fat, pain elicited by firm examination of the right iliac fossa, and localized hypokinesis of the bowel loops [28]. Appendiceal scleracolith was found in 3.9% of cases in our series. Our results were lower than those of Chinbo, who reported scleracolith in 11% of patients [23]. It is not a sufficient indicator to diagnose appendicitis, as it is found in patients with healthy appendices [11] [25]. However, its presence is a predictive sign because it can lead to secondary inflammation with a risk of perforation. A periappendiceal fluid collection was found in 17.7% of cases in our series. Our results were similar to those of Elleuch, who found periappendiceal effusion in 20% of patients. Löfvenberg F and Bergeron E found 16% and 28.68%, respectively [17] [28]. It is an indirect sign, the presence of which can have several interpretations. If it becomes echogenic, it may suggest periappendicular suppuration or peritonitis [15] [17] [29]. If it extends to the pouch of Douglas or between the loops of the bowel, it may suggest early peritonitis [15] [17] [29]. Ultrasound had a sensitivity of 100% and a specificity of 64.28%, a positive predictive value (PPV) of 88.09%, and a negative predictive value (NPV) of 100%. The sensitivity of ultrasound in our study was higher than that of M. Mor Tall and Bergeron E *et al.*, who found 96.84% and 92.32%, respectively; however, the specificity remained lower than those found in their studies, at 91.03% and 92.04% of cases. The low specificity was explained by the fact that this clinical form serves as a “catch-all” where all uncertain ultrasound diagnoses or more serious surgical diagnoses (abscess, phlegmon, peritonitis) that were missed by ultrasound were collected [17] [28]. However, when ultrasound does diagnose an abscess, it is always correct (PPV = 100%). For peritonitis and phlegmons of appendiceal origin, we found: a sensitivity of 100%, a specificity of 100%, a PPV of 100%, and a NPV of 100%. Our results were comparable to those of Rothrock SG, who found a sensitivity of 96.77% and a PPV of 96.77% [16]. Performance is perfect (100%) when ultrasound clearly identifies peritonitis or phlegmon. Thus, ultrasound, due to its sensitivity and specificity, proves to be a very valuable examination in acute appendicitis. The performance of expert hands reaches a rate of up to 98%, making it possible to confirm or rule out the diagnosis of acute appendicitis in doubtful cases. False positives in appendiceal ultrasound at the Kalale Clinic encompass causes such as resolving appendicitis, ileal Crohn’s disease, adnexal pathologies, mesenteric adenitis, and anatomical variations in caliber. False negatives are mainly explained

by an atypically positioned appendix, focal inflammation, early perforation, patient obesity, or significant intestinal distension. The study's limitations lie in its single-center design, sample size, potential selection bias, and non-standardized operator-dependent nature.

4.4. Surgical Therapeutic Data

In our study, surgery corrected 5 diagnoses, representing 9.80% of cases. The sensitivity of ultrasound was low (60%), as demonstrated by the surgical intervention, which identified 40% of the abscesses (4 cases) missed by ultrasound.

5. Conclusion

The sensitivity and specificity of ultrasound were close to 100% in our study. Comparison between the ultrasound image and the postoperative findings showed good agreement, particularly for the diagnosis of complicated cases, thus allowing for better surgical planning. These results are not necessarily generalizable to patients with negative or indeterminate ultrasound examinations. Nevertheless, ultrasound remains operator-dependent. Ultrasound should not replace the surgeon's judgment, but rather be integrated into a broader range of factors.

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Author Contributions

Conceptualization: Ouncoumba Diarra and Ousmane Traore; Review: Mamadou Dembélé, Alassane Kouma, Ousmane Coulibaly; Data analysis: Brahim Doumbia, Hama Ouologuem; Coordination: Mahamadou Diallo and Adama Diaman Keita.

Conflicts of Interest

The authors declare that there was no conflict of interest surrounding this study.

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