



SAINT PAUL'S MILLENNIUM MEDICAL COLLEGE

DEPARTMENT OF RADIOLOGY

**The Relationship between Ultrasound and Intra-operative Findings of Appendicitis
in Saint Paul's Hospital, Addis Ababa Ethiopia**

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Advisor: Dr Samuel E. (MD, Radiologist)

Mr Awol Seid

A research Submitted to the Department of Radiology, Saint Paul's Millennium Medical College
for Partial Fulfillment of the Requirements for the Specialty Degree in Radiology.

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Addis Ababa, Ethiopia

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REASERCH APPROVAL

This research by **Dr Tesfahun Tiruneh(MD)** is accepted in its presented form by examiners in satisfying research requirement for the Specialty certificate in radiology.

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Abstract

Background: Appendicitis is one of the most common causes of acute abdomen in the world including Ethiopia. Appendicitis is the inflammation of the vermiform appendix which is located in the right lower quadrant on the posteromedial wall of the cecum. It might be complicated or simple. Complicated appendicitis is appendicitis in the presence of gangrene, perforation or abscess around the inflamed appendix whereas simple appendicitis refers to appendicitis in the absence of perforation, gangrene or peri-appendicular abscesses. Being the common cause of acute abdomen knowing the potential pitfalls in ultrasound diagnosis of appendicitis is crucial for patient management.

Aims: The main aim of this study is to determine the relationship between ultrasound and intra-operative findings of appendicitis in Saint Paul's Hospital.

Methodology: A cross sectional study design was conducted in Saint Paul's Hospital and the data was extracted from patients' charts. A simple random sample of 233 patients was involved. To collect the necessary data, a structured checklist was prepared and the data was collected by trained data collectors. Then, the data is entered, and analyzed by using SPSS statistical software. In the analysis, the sensitivity of the ultrasound was determined including its 95% confidence interval. In addition, the relationship between the ultrasound and intra-operative findings is determined using a multinomial logistic regression. Ethical clearance has been secured from SPHMMC department of radiology.

Result: Appendicitis is found to be common in adolescents and adults than other age groups and males more common than females with male: female of 1.79:1. Among 209 patients who undergo appendectomy the overall sensitivity of ultrasound in diagnosing appendicitis is about 94.7%. The ultrasound finding of simple appendicitis corresponds to 60.5% of patients who have simple appendicitis intraoperatively. Appendiceal diameter of >10mm is seen in more than 60% of patients who have phlegmonous and gangrenous appendix intraoperatively.

Conclusion and recommendation: ultrasound can make diagnosis of acute appendicitis with high specificity. Despite we need other parameters appendiceal diameter of more than 10 mm can predict possibility of having phlegmonous and gangrenous appendicitis. Further prospective study is recommended to prove this finding in the study.

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List of Acronyms

SPHMMC- Saint Paul's Hospital Millennium Medical College

AA - Acute Appendicitis

GC - Gregorian Calendar

US - Ultrasound

MRN - Medical Record Number

1. Introduction

1.1 Background

The term “appendicitis” is first coined by Reginald Fitz, a professor of pathologic anatomy at Harvard. He identified the appendix as the primary cause of the right lower quadrant inflammation. Now a day’s the term appendicitis implies the inflammation of the vermiform appendix which is located in the right lower quadrant on the posteromedial wall of the cecum, about 2 cm below the ileocecal valve.

Appendicitis might be complicated or simple. Complicated appendicitis is appendicitis in the presence of gangrene, perforation or abscess around the inflamed appendix whereas simple appendicitis refers to appendicitis in the absence of perforation, gangrene or peri-appendicular abscesses (10).

Looking at the complaints of appendicitis, abdominal pain is the primary one followed by vomiting with migration of the pain to the right iliac fossa (18). However, this classical presentation is quite often absent, either due to variation in the anatomic position of the appendix or the age of the patient, with atypical presentations seen often in infants and elderly patients. (10).

Appendicitis is the most common cause of emergency abdominal surgery in the world with life. Overall postoperative complication rates ranged from 10 and 19% for simple AA and up to 30% in cases of complicated AA (16). Appendicitis is less common in Africa compared to some Asian countries and America with reported life time prevalence of 16%, 9% and 1.8% in South Korea, USA and Africa respectively (2). Despite it is less common, appendicitis now a days is common cause of acute abdomen in Africa. For instance, it is a leading cause of acute abdomen in Nigeria accounting about 30.3% causes (12).

Literatures also show that appendicitis is a primary cause of acute abdomen in Ethiopia. It is the commonest emergency abdominal surgery accounting 46.7% & 52% of cases in Zewditu Memorial & Black Lion Hospitals, respectively (1, 15, 17, 26).

Real-time compression US for diagnosis of appendicitis was first introduced by Puylaert in 1986 can be very help full to clear confusions in the clinical diagnosis of appendicitis. Graded

compression US is performed in a step-wise approach and aims to optimize visualization of the appendix (8). Recently, it has been shown that the diameter of the normal appendix (mean anteroposterior diameter $4.4\pm0.9\text{mm}$, mean transverse diameter $5.1\pm1.0\text{mm}$) does not change with age and is normally distributed in children. (4)

The sonographic findings suggestive of diagnosis of acute appendicitis includes diameter more than 6mm, incompressibility, target sign, single wall thickness 3mm or more, increased blood flow on color doppler and presence of appendicolith. There are also secondary signs of inflamed appendix including echo surrounding reflective mesentery, periappendiceal fluid collection, local abscess collection, thickening of bowel, lymphadenopathy and signs of secondary bowel obstruction (8). Appendicitis can be classified into three based on the ultrasound finding as catarrhal in which there is a clear layer structure of the appendiceal wall and mucosal edema; phlegmonous where there is an ill-defined layer structure of the appendiceal wall with moderate enlargement of the appendix, and maximum transverse dimension is $>$ or $=$ 10 mm and gangrenous in which there will be no identifiable layer structure of the appendiceal wall and marked enlargement to form a mass. (29)

There are much pathology that may simulate appendicitis both clinically and on ultrasound. This includes diverticulitis, salpingitis, peri appendicitis, adenocarcinoma of the cecum and ileocecal valve, and nonspecific inflammation of the terminal ileum and right colon (11). But, the magnitudes of these possible mimickers of appendicitis are not known to date in Ethiopia.

Therefore, determining the relationship between ultrasound diagnosis of appendicitis and intra-operative findings is a medical concern which is crucial for patient management.

1.2 Statement of the Problem

Appendicitis is also common cause of acute abdomen in Ethiopia being first or second cause of acute abdomen. Studies done in Black lion and DilChora Hospitals showed appendicitis as leading cause of acute abdomen accounting 52% and 43.1% of cases respectively. In addition, studies done in Wolayta Sodo and Gonder University Hospitals showed that acute appendicitis as second most common cause of acute abdomen next to appendicitis accounting 31.5% and 34.6% respectively (1, 15, 17, 26).

Despite it's the daily routine to see a patient with appendicitis the diagnosis of the patient is not always straight forward both clinically and on ultrasound due to various mimickers. This may include mesenteric lymphadenitis, diverticulitis, omental infarction, Epiploic appendicitis, urolithiasis, ovarian cysts and adnexal torsion. The clinical doubt regarding potential mimickers (causes of right lower quadrant pain) can be mostly solved by imaging but there are other causes or potential mimickers of appendicitis on ultrasound. This may include Mesenteric adenitis, inflammatory bowel disease, infectious terminal ileitis, Henoch–Schönlein purpura, Meckel's diverticulum, and intussusception (14).

Finding out potential mimickers of appendicitis; determining the sensitivity of ultrasound diagnosis of appendicitis; and percentage of complicated & simple appendicitis can be achieved by comparing the sonographic findings with intra-operative and pathologic findings. To date, there is hardly published report comparing intra-operative findings with ultrasound findings in Ethiopia. As a result, this study aims to determine the sensitivity of ultrasound diagnosis of appendicitis, prevalence of complicated appendicitis and identify common pitfalls of ultrasound diagnosis of appendicitis.

1.3 Significance of the Study

Being one of the most common causes of acute abdomen identifying potential mimickers of appendicitis is crucial for improving diagnosis and quality of the diagnosis of appendicitis improves quality of patient management. Identifying potential mimickers can help to reduce negative appendectomy.

And hence the results of this study will be used as an input and provide recommendation for the relevant stakeholder.

2. Literature Review

2.1 Prevalence of Appendicitis

Appendicitis results from inflammation of the vermiform appendix and is the most common abdominal condition requiring emergency surgery. (26) It may result in perforation, abscess formation, generalized peritonitis, bowel obstruction and rarely death with a mortality rate of 0.08%, rising to 0.5% in the event of a perforated appendix. (3)

The lifetime prevalence of appendicitis is about 7 %. (8). The incidence of appendicitis is approximately 1 per 1,000 per year (9). Studies done in Zewditu memorial hospital& Black Lion Hospital showed that it is the commonest emergency abdominal surgery accounting 46.7 % & 52% of cases respectively.

2.2 Clinical and Traditional Risk Factors of Appendicitis

The exact cause of AA was not clearly known, but there are probably many contributing factors. The primary cause is probably luminal obstruction, which may result from fecaliths, lymphoid hyperplasia, foreign bodies, parasites and primary neoplasms or metastasis but these tend to be exceptions rather than regular occurrences. Although several infectious agents are known to trigger or be associated with appendicitis the full range of specific causes remains unknown. Recent theories focus on genetic factors, environmental influences, and infections. (2)

Regarding the traditional factors, appendicitis is more common in adolescents 10-15 years of age and adults 16-59 years of age being 30.1% and 32.5% respectively. However, it may occur at any age including young children <5years of age and elderly >60 years of age with reported percentage of 2.1% and 0.6% respectively (13). It's common among males than females with reported male to female ratio ranging from 2:1 to 3.9:1. (5, 14).

2.3 Imaging Diagnosis of Appendicitis

The diagnosis is not always straightforward, particularly in younger patients who are unable to verbalize symptoms and in whom the historical timeline is imprecise. The rate of misdiagnoses at initial presentation is cited to be as high as 57% in children younger than 12 years and as high as 100% in children younger than 2 years (21). Perforation rates mirror these statistics, increasing to 23%–73% in young children and as high as 100% in infants younger than 1 year of

age, compared with 16%–39% in adults. Preoperative diagnosis is reported as being uncertain in one-third to one-half of cases in which patients underwent surgery, and a negative appendectomy rate (equating with an unnecessary operation) as high as 25% has been accepted in lieu of delay in prompt surgical intervention. (23) So, imaging plays important in the diagnosis of appendicitis and reducing negative appendectomy.

The imaging modalities used for diagnosis of appendicitis include US, CT, and MRI (6). US is inexpensive, does not expose the patient to ionizing radiation, and is recommended by the American College of Radiology as the first-line imaging modality in children and pregnant women (24). However, it is operator dependent and may pose difficulties for viewing the appendix in obstetric patients and patients who are obese, and retrocecal appendixes. (20, 21, 24, 7).

2.4 Sensitivity and Specificity of US

Pooled sensitivities and specificities of US for diagnosis of appendicitis in children were 91.3% (95% CI: 83.8%, 95.5%) and 95.2% (95% CI: 91.8%, 97.3%), respectively; and in adults, the pooled sensitivities and specificities were 83.1% (95% CI: 70.3%, 91.1%) and 90.9% (95% CI: 59.3%, 98.6%), respectively (13)

However, these sonographic findings can be seen in other conditions simulating appendicitis including Granulomatous appendicitis, Mild chronic inflammation, lymphoid hyperplasia, Fibrosis of appendiceal tip and lymphoid hyperplasia. (11)

CT can be used as a second-line imaging modality when an initial US is non-diagnostic. However, CT exposes patients to ionizing radiation, which is of special concern in pediatric and obstetric populations. MRI represents another diagnostic test option. This diagnostic modality does not expose the patient to ionizing radiation and is currently recommended by the American College of Radiology following an equivocal US in pregnant women (24).

3. Objectives

3.1 General Objective

- To determine the relationship between ultrasound and intra-operative findings of appendicitis in Saint Paul's Hospital.

3.2 Specific Objectives

- To assess sensitivity of ultrasound diagnosis of appendicitis.
- To determine the prevalence of complicated appendicitis both in the ultrasound and intra-operative findings.
- To find out the common pitfalls in sonographic diagnosis of appendicitis.

4. Methods and Materials

4.1 Study Area and Period

The study was conducted in SPHMMC Addis Ababa Ethiopia. The study was conducted from March 30 to June 30 2019 GC.

4.2 Study Design

Cross sectional study design was used.

4.3 Source Population

The source population includes all patients who undergo ultrasound and appendectomy.

4.4 Study Population

Study population includes selected patients with ultrasound diagnosis of appendicitis who undergo appendectomy.

4.5 Sampling and Sample Size Determination

The sample size is determined using the single population proportion formula. The three common factors has been taken into consideration for determining sample size are level of significance (α), margin of error (d) and estimated baseline level, in this study prevalence of appendicitis, of the indicator to be measured (p). Then, the initial sample size (n_0) is given by

$$n_0 = \frac{z_{\alpha/2}^2 \times p(1-p)}{d^2}.$$

A study done in Black Lion Hospital reveals the prevalence of appendicitis in patients with acute abdomen is about 52% (15). Then, assuming the significance level $\alpha = 5\%$ which results the critical value of the normal distribution to be $z_{0.025} = 1.96$ and margin of error $d = 0.05$, the

initial sample size for this study is about $n_0 = \frac{1.96^2 \times 0.52(1-0.52)}{0.05^2} \approx 384$.

The total number of patients who have undergone appendectomy in Saint Paul's Hospital is about 457. Consequently, the final sample size (n) can be adjusted for this population size as:

$$n = \frac{n_0}{1 + \frac{n_0}{N}} = \frac{384}{1 + \frac{384}{457}} \approx 209$$

But, in order to ensure sufficient level of precision, the sample size must be adjusted also for the possible anticipated response rate (*RR*). Thus, by adding a 90% response rate, the final sample size will be increased to 233. That is, of the total 457 patients with appendectomy, a sample of 233 will be involved in this study. Therefore, a random sample of 233 patient charts will be selected by simple random sampling technique using lottery method.

4.6 Inclusion criteria

All patients who have undergone ultrasound and appendectomy will be included.

4.7 Study Variables

4.7.1 Dependent Variable

The dependent variable is intra-operative findings with 7 possible outcomes defined as follows.

$$\text{Intraoperative findings} = \begin{cases} 1 = \text{Normal} \\ 2 = \text{Acutely inflamed} \\ 3 = \text{Gangrenous} \\ 4 = \text{Perforated} \\ 5 = \text{Perforated with abscess formation} \\ 6 = \text{Phlegmonous} \\ 7 = \text{Other findings} \end{cases}$$

4.7.2 Independent Variables

The potential independent variables to be considered are as follows.

- Ultrasound findings = {
 - 1 = Normal
 - 2 = Acutely inflamed
 - 3 = Gangrenous
 - 4 = Perforated
 - 5 = Perforated with abscess formation
 - 6 = *Phlegmonous*
 - 7 = Equivocal
 - 8 = Other findings
- Diameter of appendix
- Compressibility (Compressible, Incompressible)
- Appendicolith (Present, Absent)
- Increased flow on Doppler (Yes, No)
- Sex (Male, Female)
- Age
- Place of residence (Rural, Urban)

4.8 Data Collection Procedure

A structured checklist prepared in English language will be used to collect the necessary data from patients' charts. The checklist tool will have 4 sections; demographic characteristics, sonographic findings, intra-operative and pathologic findings. The data will be collected by 3 trained radiology residents. A one-day training will be given to them on how to collect data.

4.9 Data Management and Analysis

4.9.1 Data Management

In this study, the collected data entry will be entered to the statistical software SPSS version 20. Then, the data will be examined using SPSS for possible errors. This will be done by printing frequencies and percentages for qualitative variables, and descriptive statistics (measures of central tendency and measures of variation) for continuous variables. Cross tabulation will be used to assess relationship between intraoperative and ultrasound finding variables. In addition, graphical presentations will be used.

4.9.2 Determining Sensitivity of US

The sensitivity of the ultrasound is the probability that the ultrasound correctly indicates there is an appendicitis given the patients has a disease. That is;

$$p = \frac{\text{Number of patients with appendicitis identified by US}}{\text{Total number of patients who have appendicitis}}.$$

Therefore, the sensitivity of the ultrasound will be determined and also, its corresponding 95% confidence interval will be constructed.

4.10 Data Quality Control

During data collection and training there was strict supervision by the investigator. Each checklist will be checked for completeness. After entering the data in SPSS, the data was examined for possible data processing errors.

4.11 Ethical Considerations

Ethical clearance was obtained from the St Paul's hospital administration to use the patients' radiologic and epidemiological data for this specific research without mentioning patients' identity at any of the course of the study except questioner.

4.12 Dissemination of Results

After accomplishing the study, the results will be presented to the Department of Radiology and Surgery. In addition, attempts will be made to present it on scientific conferences and publish it on scientific journals.

Result

5.1 Demographic Characteristics

Among patients who undergo appendectomy 134(64.1%) of patients were males and 75(35.9%) of patients were females with male: female ratio of 1.79:1 and most of patients (64.8%) were urban dwellers. Of the urban dwellers 53% has complicated appendicitis while 47.2% has simple appendicitis. The mean age of diagnosis of appendicitis was 25.5 years with most of patients are adolescents and young adults.

5.2 Sonographic Findings and Parameters Used for the Diagnosis of Appendicitis

Of all patients who undergo appendectomy most (75.1%) patients has ultrasound diagnosis of acute appendicitis followed by appendiceal abscess, perforated appendicitis, phlegmons appendicitis and equivocal ultrasound finding. The other patients have alternative diagnosis other than stated in the table below (table 5.1) including intra-abdominal abscess, intussusception and appendiceal mass accounting 1.9% and 1.4% respectively. Appendix was not visualized in 1.4% of patients with appendicitis.

Ultrasound finding	Frequency	Percentage
Normal	3	1.5
Acute appendicitis	157	78.9
Gangrenous	2	1
Perforated	10	5
Appendiceal abscess	12	6
Phlegmonous	9	4.5
Equivocal	6	3
Total	199	100

Table 5.1 ultrasound findings of patients who undergo appendectomy

Among the parameters used for ultrasound diagnosis of appendicitis compressibility is the second most commonly used parameter for ultrasound diagnosis of appendicitis next to appendiceal diameter. In most patients with appendicitis appendix is found to be non-compressible. Compressibility in patients with appendicitis is mostly associated with perforation and abscess formation. Other primary and secondary signs of appendicitis documented in some patients with appendicitis include increased blood flow (100%), increased echo reflectivity of the adjacent mesentery (99.1%), lymphadenopathy (100%) and abscess formation (6.4%). However, this signs except echo reflective mesentery are described in ultrasound findings of few patients with appendicitis.

Appendicitis can be classified into complicated and uncomplicated. In our study among all patients who undergo appendectomy about 75.1% of patients has simple appendicitis based on the sonographic finding.

5.3 Intraoperative Findings

The most common intraoperative finding in patients who undergo appendectomy in St, Paul's Hospital is acutely inflamed appendix followed by appendiceal phlegmon and appendiceal abscess accounting 50.2%, 24.9% and 15.8% respectively. Other intraoperative finding includes intra-abdominal abscess (0.5%) and Valentino Syndrome (0.5%). The most common associated surgical finding was reactive fluid which was seen in about 13.4% of patients who undergo appendectomy.

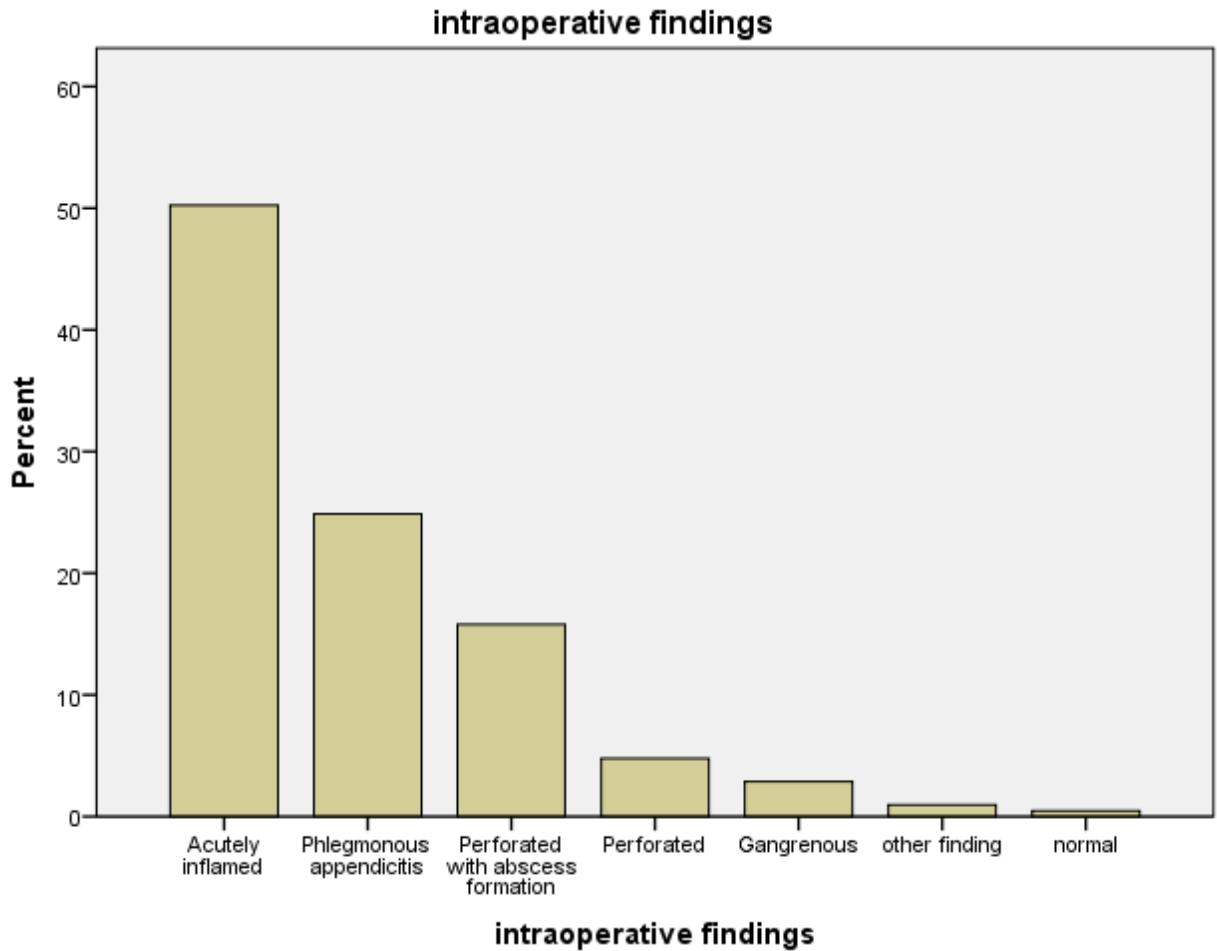


Figure 5.1 intraoperative findings of patients who undergo appendectomy

Nearly equal number of patients who undergo appendectomy has simple and complicated appendicitis in shown in fig 5.2 with 50.5% of patients having simple and 49.0% of patients having complicated appendicitis. The prevalence of complicated appendicitis is slightly higher in rural dwellers owing to easy access to the hospital.

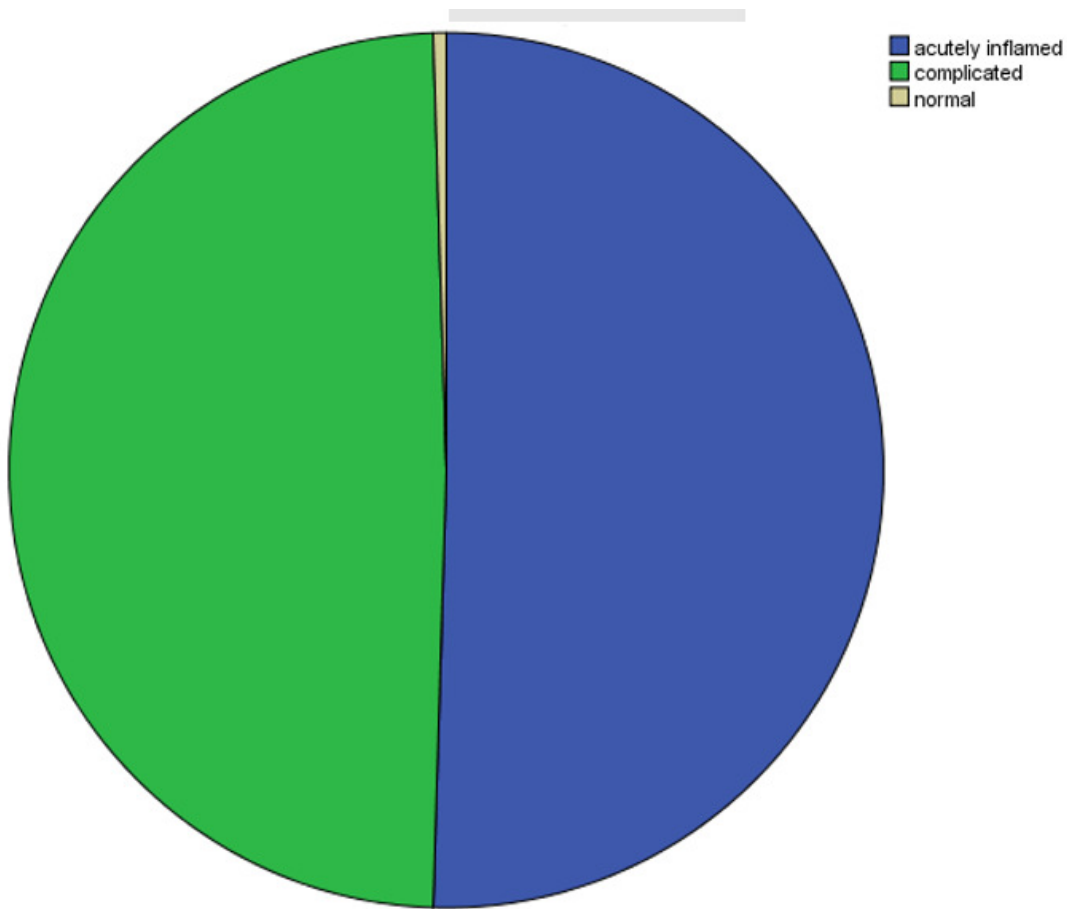


Fig 5.2 intraoperative finding of patients as complicated and uncomplicated appendicitis

5.4 Correlation between complicated appendicitis and appendiceal diameter

In our study as we can see in the cross-tabulation table below we can see that as the diameter of the appendix increases the likelihood of having complicated forms of appendicitis namely phlegmonous and gangrenous is increased. However, there is poor correlation between the increased appendiceal diameter and likely hood of having appendiceal abscess.

		Appendix diameter			Total
		< 6mm	6-9.99mm	10-20mm	
Intraoperative finding(n=194)	Acutely inflamed	3 (2.9%)	87 (85.3%)	12 (11.8%)	102 100%
	Gangrenous	0 (0%)	2 (40%)	3 (60%)	5 (100%)
	Perforated	0 (0%)	4 (40%)	6 (60%)	10 (100%)
	Appendiceal abscess	1 (3.7%)	16 (59.3%)	10 (37%)	27 (100%)
	Phlegmonous appendicitis	1 (2%)	16 (32.7%)	32 (65.3%)	49 (100%)
	Other	0 (0%)	0 (0%)	1 (100%)	1 (100%)
Total		5 (2.6%)	125 (64.4%)	64 (33.0%)	194 (100%)

Table 5.2 intraoperative finding versus diameter of appendix cross tabulation.

5.5 Sensitivity of ultrasound diagnosis of appendicitis

The overall sensitivity of ultrasound in diagnosing any form of appendicitis based on the surgical finding about is 94.7% assuming equivocal cases as positive and 90.9% assuming equivocal cases as negative. About 57.6% of patients diagnosed to have simple appendicitis on ultrasound are found to have simple appendicitis intraoperatively. This tells us that ultrasound can detect a smaller number of patients with specific forms appendicitis. This may be attributed to retrocecal position of the appendix, pregnancy, obesity or delayed surgical intervention. The latter is owing to due to the fact that appendicitis progresses from simple to complicated forms of appendicitis

as time goes for surgery. However, we have limited data for to assess the sensitivity of ultrasound in the specific forms of appendicitis.

It could have been better if we try to interoperate the sensitivity of ultrasound based on the pathology finding however, limited data is available as pathology was done only in 3 or 1.5% of our study population.

5. Discussion

Appendicitis is found to be more common in male than females with male to female ratio of 1.79:1 which is in keeping with previous studies done in Zewditu Memorial Hospital and India. (5, 14). This study also showed that it's common in adolescents and adults as compared to children and elderly as it's also reported in the world. (13)

Regarding the ultrasound diagnosis of appendicitis, it's 94.7% sensitive in diagnosing any form of appendicitis which is relatively higher as compared to worldwide study published by RSNA. (13) This may be due to relatively lower prevalence of obesity in Ethiopia. However, ultrasound detects only about 29.7% of patients with specific form of complicated appendicitis which is lower than 37.3% which is reported in US. (28) This may be attributed to retrocecal position of the appendix, pregnancy, obesity, delayed surgical intervention.

Complicated appendicitis is about three-fold more common in Ethiopia than reported in US, about 49.0% our patients have complicated appendicitis as compared to US which is reported to be about 16.2%. (28) This may be attributable to lack of early access to institution capable of diagnosing and treating appendicitis.

Intraoperatively 15.8% of patients are found to have appendiceal abscess which is relatively high as compared to previous study done in Zewditu Memorial Hospital which is reported to be 2.5%. However, the percentage of perforated and gangrenous appendicitis is relatively low. In our study it is found in 4.8% & 2.9% patients respectively while it is found 17.4% and 9.5% patients in Zewditu Memorial Hospital. (5)

Despite there is an ultrasound diagnosis of intussusception in about 1.4% of patients intraoperatively they are found to be appendiceal phlegmon/masses this suggests that appendiceal mass could be mistaken as intussusception and care had to be taken not to mistaken appendiceal mass as intussusception. As it can be expected that treatment of intussusception is hydrostatic reduction followed by laparotomy expecting that hydrostatic reduction is not efficient in appendiceal mass. This may lead to unnecessary laparotomy. Ultrasound diagnosis of intra-abdominal abscess was made in three patients while only one patient has normal appendix intraoperatively. This suggests that the ultrasound diagnosis of appendiceal abscess may be difficult since the appendix can be amputated and collapsed as it ruptures to give an abscess so

surgeons need to note a right lower iliac fossa intra-abdominal abscess can also be appendiceal abscess.

There is significant correlation between the increased diameter of the appendix and likely hood of having complicated forms appendicitis namely gangrenous and phlegmonous appendicitis as described by Himeno. (29) However, it may be inappropriate to conclude diagnosis of gangrenous and phlegmonous appendicitis based on the appendiceal diameter as patients with appendix diameter of more than 10mm could also have simple appendicitis. In our study about 11.8% of patients with appendiceal diameter of more than 10mm have simple appendicitis. In such scenario we need to see the wall of the appendix as ill definition of layers of the wall or absence of definition of the wall of the appendix can tell as the presence of phlegmonous or gangrenous appendicitis respectively. (29)

6. Strength of the study

- Clear tittle with clear inclusion and exclusion criteria
- It was the first study conducted in Ethiopia and Africa
- Despite the limitation the we try to address sensitivity of ultrasound in the cost-effective way
- We try to show the gaps for future prospective study

7. Limitation of the study

- Surgical/gross finding is not the gold standard diagnostic tool for diagnosis of appendicitis which in turn may affect the sensitivity of ultrasound.
- Inadequate documented primary or secondary ultrasound findings for the diagnosis appendicitis.
- There is delay in surgical intervention of patients with appendicitis which could affect the sensitivity of ultrasound.

8. Conclusion

Appendicitis is common clinical condition that every physician need to know how to reach appropriate diagnosis of appendicitis. Our study showed that ultrasound plays important role in diagnosis of appendicitis with high sensitivity despite it has lower sensitivity in diagnosis of specific forms of appendicitis. Increased appendiceal diameter more than 10mm can predict probability of having phlegmonous and gangrenous appendicitis but we need to look for appendiceal wall layers to make diagnosis. Appendiceal mass can be mistaken as intussusception on ultrasound and diagnosing radiologist or sonographer need to be cautious about it. Conversely a right lower quadrant abscess can be appendiceal abscess and surgeons need to be look appendix.

9. Recommendation

- The MOH should work on easy access for hospitals capable of diagnosing and treating appendicitis.
- Surgeons need to look for appendix in patients with right lower quadrant abscess.
- Prospective study with close look into sonographic findings of the specific forms' appendicitis should be done to confirm the findings in this study.

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Annex: Data Collection Check List

MRN: _____

Part I: Demographic Characteristics

Q1. Age (in years): _____

Q2. Sex:

1. Male
2. Female

Q3. Place of residence

1. Rural
2. Urban

Part II: Sonographic Findings and Parameters Used for the Diagnosis of Appendicitis

Q4. Reported ultrasound conclusion:

1. Normal
2. Acute appendicitis
3. Gangrenous
4. Perforated appendicitis
5. Appendiceal abscess
6. Phlegmonous appendicitis
7. Equivocal
8. Other specify _____

Q5. Direct signs of appendicitis:

Q5.1. Diameter of the appendix in mm _____

Q5.2. Compressibility

1. Compressible
2. Incompressible

Q5.3. Appendicolith

1. Present
2. Absent

Q5.4. Increased flow on Doppler

1. Yes

2. No

Q6. Presence of secondary signs of appendicitis

1. Echo- reflective mesentery
2. Peri- appendiceal fluid
3. Mesenteric LAP
4. Abscess formation
5. Adjacent bowel wall thickening
6. Other specify_____

Part III: Intraoperative Findings

Q7. Reported intraoperative Findings

1. Normal
2. Acutely inflamed
3. Gangrenous
4. Perforated
5. Perforated with abscess formation
6. Phlegmonous appendicitis
7. Other specify_____

Part IV: Pathologic finding

Q8. Did the sample send for biopsy?

1. Yes
2. No

Q9. If yes for Q8, reported conclusion from the biopsy.

1. Normal
2. Acute Suppurative/ Ulcerative Necrotic
3. Chronic Nonspecific Appendicitis
4. Lymphoid Hyperplasia
5. Submucosal fibrosis
6. Granulomatous appendicitis
7. Mild chronic inflammation
8. Other specify_____