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Agreement of Ultrasound and Intraoperative Findings in The Diagnosis of Acute Appendicitis and its Associated Factors

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**BAHIRDAR UNIVERSITY COLLEGE OF MEDICINE AND
HEALTH SCIENCES DEPARTMENT OF CLINICAL RADIOLOGY**

**AGREEMENT OF ULTRASOUND AND INTRAOPERATIVE
FINDINGS IN THE DIAGNOSIS OF ACUTE APPENDICITIS AND
ITS ASSOCIATED FACTORS**

BY: DR. MENGISTU ABIYOT

**THESIS SUBMITTED TO THE DEPARTMENT OF RADIOLOGY
COLLEGE OF MEDICINE AND HEALTH SCIENCE BAHIRDAR
UNIVERSITY IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE SPECIALITY CERTIFICATE IN
CLINICAL RADIOLOGY**

FEBRUARY 2022 G.C

BAHIRDAR UNIVERSITY COLLEGE OF MEDICINE AND
HEALTH SCIENCES DEPARTMENT OF CLINICAL RADIOLOGY

AGREEMENT OF ULTRASOUND AND INTRAOPERATIVE
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ITS ASSOCIATED FACTORS

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Assurance of Investigator

I the undersigned resident agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress report to my advisors and seek the necessary advice and approval from my advisors in the course of the research. I will also communicate timely to my advisors and all stakeholders involved in the study.

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Approval of Advisors

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Signature:

Date:

Declaration Form

I, the under signed, declared that this my original work, has never been presented in this University and all the resources and materials used for the research have been fully acknowledged.

Principal investigator

MENGISTU ABIYOT (MD, Radiology Resident)

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Advisors

1. Keadnew Mulatu (Assistant professor of Epidemiology)

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2. G/tsadik Zegeye(MD,Assistant Professor Of Radiology)

Signature -----date -----

Approval thesis for defense result

We hereby certify that we have examined this thesis entitled “the agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis and its associated factors in TGSB and FHRCH ; a cross sectional study”, submitted in partial fulfillment of the requirements for specialty certificate in Clinical Radiology by Mengistu Abiyot. We recommend that ----- is approved for specialty certificate in Clinical Radiology.

Board of Examiners

Examiner's name	Signature	Date
1 Dr.Aklilu Tesega (Radiologist)	_____	
2 Mr.Habtamu	-----	

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List of Abbreviations and acronyms

CT.....computed tomography

TGSH.....Tibebe Ghion Specialized Hospital

FHCRH.....Felegehiwot comprehensive and referral hospital

US.....Ultrasound

GP.....General practitioner

BMI.....Body mass index

PPV.....positive predictive value

NPV.....Negative predictive value

USA.....United States of America

Intra OP.....intraoperative

Abstract

Background: Acute appendicitis is one of the most common acute abdomen presentation. Clinical and laboratory findings are the mainstay of diagnosis of acute appendicitis. But the clinical diagnosis is not always straightforward, specially in patients who have atypical clinical presentation. Delay in diagnosis result in complications and false positive diagnosis also leads to unnecessary negative appendectomy. Ultrasound is said to be the mainstay imaging modality to diagnose appendicitis.

Objective: The objective of the study was to assess the agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis and its associated factors

Methods and materials: Institutional based cross sectional study was conducted. The study was conducted from September 2021 to November 2021 G.C. The sample size was 337, and all patients who were clinically suspected of acute appendicitis and send to Radiology department for ultrasound scanning were included.

Results: There is very good (strong) agreement between ultrasound finding and intraoperative finding with Kappa value of 0.822(95%CI). The sensitivity, specificity and accuracy of ultrasound in the diagnosis of acute appendicitis is 96.7%, 94.1% and 96.4% respectively with positive predictive value of 99.3% and negative predictive value of 76.2%. Gender and qualification of personnel who has done ultrasound are significant predictors of agreement of ultrasound and intraoperative findings of acute appendicitis. Mesenteric lymphadenitis, renal stone, PID, ectopic pregnancy and other miscellaneous disease are the alternative diagnosis by ultrasound in decreasing order.

Key Words: Acute appendicitis, ultrasound, appendectomy, sensitivity, specificity

1. Introduction

1.1. Background

Acute appendicitis is one of the common presentations to the acute abdomen in the emergency department. Patients typically present with right lower quadrant pain, tenderness and leukocytosis. Lymphadenitis, Crohn's disease and other conditions overlap with acute appendicitis including typhilitis, mesenteric disease, diverticulitis, omental infarction and in women with acute gynecologic conditions such as ruptured or torsion of adnexal cyst or pelvic inflammatory disease. This overlap can lead to delayed intervention and complications such as perforation and peritonitis. Patients with a classic presentation may have an appendectomy without preoperative imaging, but this approach often leads to a negative appendectomy and other postoperative complications(1).

Acute appendicitis occurs at a rate of about 90–100 patients per 100 000 inhabitants per year in developed countries. The peak incidence usually occurs in the second or third decade of life, and the disease is less common at both extremes of age. Most studies show a slight male predominance. Geographical differences are reported, with lifetime risks for appendicitis of 16% in South Korea, 9.0% in the USA, and 1.8% in Africa(2).

The life time risk of acute appendicitis is 8.6% for males and 6.7% for women. CT scan and abdominal ultrasound are the mainstay of diagnostic imaging for acute appendicitis with accuracy of 94% and 83% respectively(3).

The full range of the cause of acute appendicitis is unknown. Recent theories suggest there are genetic, environmental and infectious factors. Direct luminal obstruction by stone, mass or fecolith can cause acute appendicitis. Patients that have a family history of acute appendicitis have a higher risk of developing acute appendicitis. Both aerobic and anaerobic bacteria are involved in the infectious cause of acute appendicitis and acute appendicitis. Seasonal variation is common and it is said to be more common in summer season(2).

The diagnosis of acute appendicitis remains one of the most challenging in surgery. The rate of unnecessary laparotomy for suspected acute appendicitis is as high as 20-25%, and the perforation rate varies between 15% and 30% in most reported series(4).

Traditionally, the diagnosis of acute appendicitis is mainly based on history, findings at physical examination, and results of laboratory tests. The rate of negative findings for appendicitis at laparotomy or laparoscopy based on these parameters may be as high as 50%. On the other hand, a delay in the diagnosis and treatment of appendicitis may increase the potential risk of a complicated clinical course (5).

Among imaging methods currently used in the clinical practice, Ultrasound is a valuable tool. It was first introduced by Puylaert in 1986, who described the graded compression technique apt to better visualize the inflamed appendix by using the graded compression technique, a linear high-frequency transducer is placed on the right lower quadrant and pressure is applied gradually while imaging, displacing overlying gas-filled loops of bowel. Moreover, this noninvasive option is repeatable, avoids the exposure to nonionizing radiation and can be less expensive as compared to CT costs. At US, findings suggestive of appendicitis include, a thickened wall, a noncompressible lumen, outer appendiceal diameter greater than 6 mm, absence of gas in the lumen, appendicoliths, echogenic inflammatory periappendiceal fat change, and increased blood flow in the appendiceal wall . If compared to other diagnostic tests, US is inferior to CT as to sensitivity; due to its low negative predictive value for appendicitis, it may not be as useful for excluding appendicitis. More recently, color and power Doppler examination of the appendix have proven to be a useful adjunct to improve the sensitivity by demonstrating increased flow in an inflamed appendix(6).

The diagnosis of acute appendicitis by ultrasound is made when the appendiceal diameter is >6mm and non compressible with probe pressure. But, there are many disease conditions which have similar clinical features with acute appendicitis and can cause periappendiceal inflammatory changes and secondary thickening of the appendix. Examples of these disease entities include crhons disease, tuboovarian abscess, typhilitis, perforated peptic ulcer, and cecal carcinoma and periappendiceal tumors(7).

The sensitivity of sonography is 79%; the specificity is 78%; the accuracy is 78%; the positive predictive value is 87%; and the negative predictive value is 65%(5). However, (8)in patients with poorly compressible right lower quadrant bowel structures, who are obese or muscular, or whose appendix is located in the retrocecal area or true pelvis, sonography using only a graded compression technique even by an experienced examiner may not be sufficient to detect the vermiform appendix and to allow accurate diagnosis of whether it is normal or abnormal(9).

1.2. Statement of the problem

Despite clinical diagnosis is the main stay of diagnosis of acute appendicitis controversies persists regarding to routine use of ultrasound for the diagnosis of acute appendicitis. Investigators agreed that 50% of the appendixes removed by surgery are normal if only clinical diagnosis is used(5).US has reported sensitivities of 75%–90%, specificities of 86%–95%, accuracies of 87%–96% and has the potential to decrease negative appendectomy(6).Other studies found that there is no significant difference between ultrasound and clinical findings using Alvarado score in diagnosing acute appendicitis. In this study ultrasound alone resulted in a correct diagnosis of 87% with 10% false negative and 4.6% false positive, and when clinical Alvarado score used alone it has 5.8% false negative and 7.2% false positive. In this study there is no advantage of ultrasound over the Alvarado score for the diagnosis of acute appendicitis. Ultrasound is unnecessary when one's degree of clinical suspicion is high(10).

Studies agreed that there are multiple disease patterns which have similar ultrasound finding with acute appendicitis which result in false positive results and negative appendectomy including crhons disease,pyelonephritis,cholecystitis,mesenteric adenitis,tubo ovarian abscess and pregnancy(11). Even though there is known disease pattern which have similar ultrasound findings with acute appendicitis there was no clear study which detects the disease pattern which has high tendency to cause false positive ultrasound for acute appendicitis and results in negative appendectomy.

Studies done in Ethiopia regarding to the agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis is very limited. There is one a study done in Tikur Anbesa Hospital on the role of ultrasound in diagnosing acute appendicitis and identify the specificity and sensitivity of ultrasound in diagnosing acute appendicitis but the study did not include the agreement of ultrasound finding with clinical diagnosis.

1.3. Significant of the study

The importance of knowing the agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis and the associated factors will answer whether there is importance of routine ultrasound for the diagnosis of acute appendicitis so that there will improve physicians confidence in diagnosis of acute appendicitis and reduce the negative appendicectomy rate; thus reducing workload of hospitals and postoperative complications, and it will also decrease delay in intervention and complications.

This study helped to know factors that affect the agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis and identified disease patterns that have similar ultrasound findings with acute appendicitis that will help the Radiologists and the treating physicians to think of these alternative diagnoses.

2. Literature review

2.1. Agreement (correlation)

There is a retrospective study done in USA on 94 patients who have appendectomy to compare the clinical Alvarado score and ultrasound for the diagnosis of acute appendicitis. In this study ultrasound alone resulted in a correct diagnosis of 87% with 10% false negative and 4.6% false positive, and when clinical Alvarado score used alone it has 5.8% false negative and 7.2% false positive. When the clinical Alvarado score is negative or equivocal the addition of ultrasound decreased the false negative by 75% and false positive become zero. This study concludes that comparing ultrasound to the Alvarado score for the diagnosis of acute appendicitis, neither one is significantly

advantageous. However, the false positive rate is reduced to zero when both studies are positive and ultrasound improved diagnostic accuracy when the Alvarado score was negative or equivocal. There is no advantage of ultrasound over the Alvarado score for the diagnosis of acute appendicitis. Ultrasound is unnecessary when one's degree of clinical suspicion is high. However, the additional information provided by ultrasound does improve diagnostic accuracy in the case of a negative or equivocal Alvarado score(10).

There is hospital based retrospective study done in Canada on 667 for the utility and diagnostic accuracy of ultrasound in detecting appendicitis shows accuracy was 92%; sensitivity, 83%; and specificity, 95%. The positive predictive value was 86%, and the negative predictive value was 94%.The study concludes that the sensitivity, specificity, accuracy, and positive and negative predicative values of sonography performed by general radiologists in a community hospital are comparable to statistics quoted in the literature for academic institutions(12).

A prospective study done in Norway on 240 patients with clinical diagnosis of acute appendicitis on the diagnostic accuracy of high resolution ultrasound for the diagnosis of acute appendicitis shows the overall sensitivity, specificity and accuracy of ultrasonography in the diagnosis of acute appendicitis were 78%, 92% and 87%, respectively. The positive predictive value was 84% and the negative predictive value was 88%. In this study perforated appendicitis, retrocaecal appendices, appendices adherent to the surrounding mesentery, and inflammation only at the tip contribute to false negative ultrasonic diagnoses. Lymphoid hyperplasia in a patient with terminal ileitis, ulcerative colitis, mesenteric lymphadenitis and gynecological disorders (tubal pregnancy and ruptured corpus luteum cyst), in their decreasing order, contribute for false positive results (4).

A prospective study done in Netherland on 199 patients with clinical signs and symptoms of acute appendicitis on the accuracy of unenhanced CT scan and graded compression ultrasound for the diagnosis of acute appendicitis found that the sensitivity of sonography

was 76%, the specificity was 83%; the positive predictive value was 90%; and the negative predictive value was 64%(5).

There is a prospective study done in Netherland, on the importance of ultrasound in the diagnosis of acute appendicitis the study was done on 525 patients with clinical signs of acute appendicitis. In this in patients with surgically proven appendicitis the inflamed appendix had been visualized sonographically in 86 percent. In patients with a subsequently confirmed alternative condition, ultrasonography made the correct diagnosis in 90% of the cases and the alternative diagnosis with decreasing in frequency are bacterial ileocaecitis, mesenteric lymphadenitis, gynaecological conditions, urological conditions, caecal diverticulitis, perforatedpeptic ulcer, Crohn's disease and miscellaneous conditions. ultrasonography has also has high negative predictive and positive predictive values This study concluded that when used to complement the clinical diagnosis ultrasonography improves the diagnostic accuracy and patient management in those suspected of having acute appendicitis(13)

There is a prospective study in San Diego, Spain done on 110 patients who are suspected with acute appendicitis on the accuracy of ultrasound in the diagnosis of acute appendicitis compared with the surgeon's clinical impression the study shows that ultrasound-derived diagnosis of appendicitis had a sensitivity of 85.5%, a specificity of 84.4%, a positive predictive value of 88.3%, a negative predictive value of 80.1%, and an overall accuracy of 85.0%. The surgeon's clinical impression at the time of admission had a sensitivity of 62.9%, a specificity of 82.2%, a positive predictive value of 82.9%, a negative predictive value of 61.7%, and an overall accuracy of 71.2%.this study concludes that the overall accuracy of ultrasonography in the diagnosis of appendicitis was statistically superior to that of the surgeon's clinical impression. However patients with normal ultrasound findings can be ultimately found to have appendicitis at operation, emphasizing the point that ultrasonography cannot be relied on to the exclusion of the surgeon's careful and repeated evaluation(14).

There is institutional based retrospective study done in Italy on 157 patients to evaluate surgeon's clinical evaluation and ultrasound in the diagnosis of acute appendicitis in comparison with intraoperative findings. The study found that sensitivity is 67.9% for clinical examinations, 77.3% for ultrasound imaging, 36.1% for laboratory investigations. Negative predictive values are low for all the methods used; the least predictive are laboratory findings (6.1%) and clinical examinations (5.7%) compared to ultrasound, which has a predictive rate of 12%. Clinical examinations produced a positive predictive value of 100% compared to 98.7% for ultrasound and 98.7% for laboratory investigations. Overall diagnostic accuracy is 74.3% for ultrasound, 68.6% for clinical examinations and 37.1% for laboratory investigations. The study concludes that it is important to incorporate ultrasound into routine practice in the diagnosis of acute appendicitis, but only and exclusively to support other diagnostic procedures and preferably within emergency departments. A thorough clinical examination of patients with suspected acute appendicitis is still the best diagnostic procedure (15).

A prospective study done on abdominal sonography screening of clinically diagnosed of acute appendicitis by treating surgeon before surgery on 191 patients who are clinically suspected to have acute appendicitis to assess the need of ultrasound in Taiwan, China found that abdominal sonography for detecting acute appendicitis had a sensitivity of 99.3%, a specificity of 68.1%, an accuracy of 91.6%, a positive predictive value of 90.5%, and a negative predictive value of 97.0%. The study suggests the routine abdominal ultrasound for patients who are suspected of having acute appendicitis. (16).

There is Hospital based cross sectional study done in Pakistan on 60 patients who are suspected of having of acute appendicitis to study diagnostic accuracy of ultrasound in acute appendicitis. The study showed that US scan has sensitivity of 88%, specificity of 92%, positive predictive value of 94%, negative predictive value of 86%, and overall

accuracy of 90%, and most accurate appendiceal finding for appendicitis was a diameter of 7 mm or larger followed by noncompressibility of inflamed appendix(17).

There is institutional based prospective study done in Iran on 75 patients who are diagnosed to be acute appendicitis and have appendectomy to find out the diagnostic value of ultrasound and clinical modified Alvarado score. This study shows that the sensitivity, specificity, PPV, NPV and accuracy rate of ultrasonography is 71.2%, 83.3%, 97.4%, 25% and 72.4%, respectively. By taking a cutoff point of 7 for the clinical modified Alvarado score, a sensitivity of 65.7%, specificity of 37.5%, PPV of 89.8%, NPV of 11.5% and accuracy of 62.7% are calculated. Using the cutoff point of 6, a sensitivity of 85.1%, specificity of 25%, PPV of 90.5%, NPV of 16.7% and accuracy of 78.7% are obtained. From this study ultrasound provides reliable findings for helping to diagnose acute appendicitis. A low cutoff point for the modified Alvarado score will yield more sensitivity and a better diagnosis of appendicitis, though with an increase in negative appendectomy(18).

A 9 years case review in Saudi Arabia on 1073 patients who are surgically treated for acute appendicitis done to assess the role of preoperative graded compression ultrasound in detecting acute appendicitis influencing the negative appendectomy rate found that positive ultrasound findings were recorded in 83.1%, while negative findings were recorded in 16.87%. Positive appendectomy was recorded in 91.6%, while negative appendectomy was recorded in 8.4%. The sensitivity was 83%, specificity was 100%, and the rate of negative appendectomy was 8.39%. The study concluded that graded compression ultrasound is valuable to reduce the negative appendectomy rate(19).

A retrospective study done in Nigeria on 149 patients who are clinically diagnosed to have acute appendicitis to show the diagnostic accuracy of ultrasound. In this study only 78 patients from 149 were having ultrasound before surgery and found to be only 19 out

of 78 patients are said to have acute appendicitis by ultrasound making the accuracy of ultrasound for detection of acute appendicitis 24.4%.The explanations put by the study for this low level accuracy in diagnosis include the use of substandard ultrasound machine with inappropriate probes of suitable frequencies for the purpose of this diagnosis. Poorly trained operator of the ultrasound machine with lack of knowledge of the proper techniques and criteria for analysis on the diagnosis' and very poor clinical history to guide the operator(20).

A prospective study done in Kenya on 112 patients, who are suspected to have acute appendicitis on the basis of history and clinical examination, was done on the correlation of ultrasound, clinical and surgical findings of acute appendicitis. In this study all patients presented with abdominal pain (100%) which was localized at right iliac fossa in (86%) patients and in (14%) patients the pain was generalized. The abdominal pain was associated with vomiting and fever in (67%) and (57%) patients respectively. Majority (99%) of the patients had abdominal tenderness with 78% of them had rebound tenderness at right iliac fossa region. Ultrasound examination of abdomen showed that, 97 out of 112 patients had findings suggestive of appendicitis in which 76 had right iliac fossa maximum tenderness, 64 had blinded ending tubular structure of diameter of 6mm or larger, 39 had fluid at right iliac fossa and echogenic peri-appendiceal fat in 25 patients. The rest of patients had normal sonographic features. All patients underwent appendicectomy and 54.5% had inflamed appendices, 28.6% perforated appendices,24.1 % abscess and 4.5% were gangrenous. The examination of the excised appendices resulted in accuracy, sensitivity, specificity, PPV and NPV of sonographic diagnosis of acute appendicitis to be 88.4%, 92%, 58.3%, 95% and 47% respectively. The overall negative appendicectomy rate of this study was 10.7%. This study concluded that ultrasound by graded compression technique is a useful adjuvant to the clinical diagnosis of acute appendicitis. It can reduce the negative appendicectomy rate without adversely affecting the perforation rate particularly in equivocal cases. However US findings should be correlated carefully with clinical findings since its negative predictive value is quite low (47%). This study also suggests that high clinical suspicion is still of paramount important in the management of acute appendicitis(21).

A cross sectional study done in Darfur, Sudan on the role of ultrasound for evaluation of acute appendicitis to evaluate the accuracy of ultrasound as compared with the operative findings on 51 patients who have acute appendicitis. The study found that 78.4% was positive ultrasound finding for acute appendicitis and 21.6% of negative findings. The surgical finding were positive in 84.3%.four patients who have negative ultrasound findings have positive finding in surgical finding. The positive predictive value was 90.0%.There were a good agreement between sonographic and surgical findings, which was statistically significant ($\kappa=0.70$ [95% CI, 0.49–0.91]). In this study, sonography has a high PPV and NPV.Sonography should be considered as a primary screening tool in the algorithm of evaluation of acute appendicitis(22).

There is a prospective institutional based study done in Ethiopia on 194 patients with suspected of acute appendicitis to assess the sensitivity, specificity and accuracy of ultrasound for the diagnosis of acute appendicitis. In this study the sensitivity of US in diagnosing acute appendicitis was found to be 87.9% with specificity of 86.5%. The positive and negative predictive values were 80.9% and 91.7%, respectively, with accuracy of 87.1%.The study showed that in 27.4% an alternative diagnosis was made by ultrasound. This study concludes that ultrasound can be used as imaging modality to diagnose acute appendicitis especially in patients who have atypical clinical presentation(23)

2.2. Associated factors

A research review done in Italy on accuracy of ultrasound in the diagnosis of acute appendicitis found that ultrasound has variable diagnostic accuracy with sensitivity range from 44% to 100% and ;specificity range from 47% to 97% .This is due to many reasons including operator ability,obesity,increased bowel gas, anatomic variant(24).

There is a case control study done in South Korea on 877 subjects with 202 control subjects and 675 patients who are suspected of acute appendicitis to study operator dependent techniques for graded compression ultrasound to diagnose acute appendicitis.

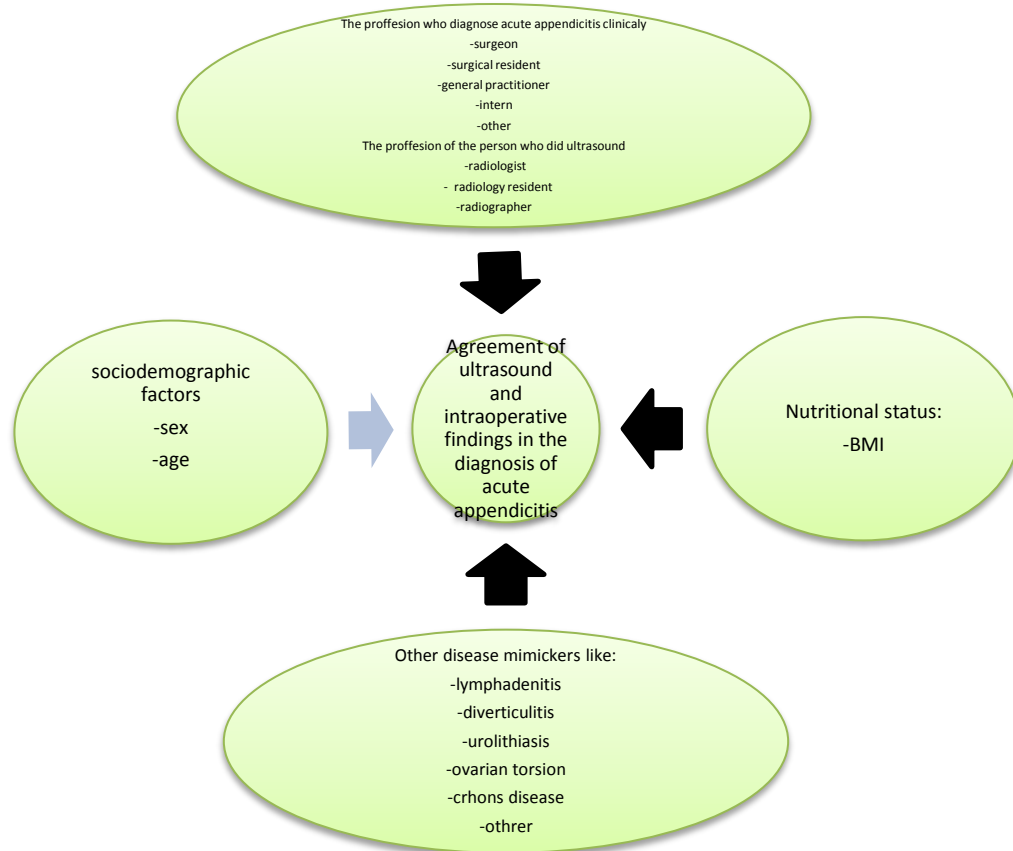
In this study the initial graded compression ultrasound examination has sensitivity of 89% and when additional use of posterior manual compression, upward graded compression, and left oblique lateral decubitus body position are used the sensitivity of ultrasound is increased to 99%. From this study the skill of the operator (Radiologist) has great effect on ultrasound specificity of diagnosing acute appendicitis(9).

A cross sectional study in Iran on the accuracy of ultrasound exam performed by trained emergency medicine versus radiology resident in the diagnosis of acute appendicitis in 121 patients with acute appendicitis on the basis of pathological result as a gold standard and found that there is a high total agreement in the diagnosis of acute appendicitis [96% agreement, $\kappa = 0.90$; 95% confidence interval (CI) = 0.81–0.99] between the two groups. The specificity and sensitivity of EM and radiology groups were 99% (95% CI = 93–100), 63% (95% CI = 48–77), 97% (95% CI = 91–100), and 72% (95% CI = 57–84), respectively. This study concludes that emergency medicine resident can perform ultrasound for acute appendicitis as accurate as a radiologist(25).

The study done in Palestine on 180 patients who are clinically diagnosed with appendicitis on the sensitivity and specificity of ultrasound for the diagnosis of acute appendicitis shows that the overall specificity and sensitivity were found to be 84.8% and 83.3% respectively. This study also shows that the accuracy of ultrasound examination varied with the age group and BMI category of patients. A significantly higher false diagnosis rate was obtained in female patients than in males. There is also false diagnosis in patients who have abnormal body mass index. In this study 82.2% of patients with false diagnosis are obese(26)

3. Conceptual framework

Figure 1.conceptual framework



4. Objectives

4.1. General objective

To determine the agreement of ultrasound and intraoperative findings in diagnosing acute appendicitis and its associated factors in TGSH and FHCRH.

4.2. Specific objectives

To determine the agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis in TGSH and FHCRH.

To identify factors associated with the agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis in TGSH and FHCRH.

5. Methods and Materials

5.1. Study area and study period

The study was conducted at TGSH and FHCRH , which is found in Bahir Dar which is the capital city of Amhara region and 578km north west from Addis Ababa. The city has 3 sub cities and 16 Kebeles. The total population of the city is 649,429 by 2012. The city has two referrals, one district hospital, 4 private hospitals, six higher clinics and health centers owned by government and private sectors. TGSH is teaching university hospital established in 2018 and has more than 350 beds for inpatient management and serving more than 8 million peoples from parts Amhara and Benshangul Gumuz as in patient and

outpatient treatment. It is the training center for undergraduate and a wide spectrum of postgraduate. The radiology department has 7 radiologists, 26 residents and 6 radiology technicians and 3 nurses. The study was conducted from September 2021 to November 2021 G.C. FHRH located along the shore of lake tana. A total of 16,289 patients visit the clinics every month. The hospital catchment area is estimated to be 5-7 million people. FHCRH is used as a teaching center for Bahir Dar University College of Medicine and Health Sciences.

5.2. Study design

The study design was institutional based cross sectional study

5.3. Source population

All patients who were clinically suspected of having acute abdomen in TGSH and FHCRH

5.4. Study population

All patients who were clinically suspected of having acute appendicitis from September 2021 to November 2021 G.C in TGSH and FHCRH

5.5. Sample size determination

The sample size was calculated using the formula $n = z^2 pq / d^2$, using p value 0.726(27)

$n = z^2 pq / d^2$ where

z is CI of 95% which is 1.96

P is proportion of patients who have acute appendicitis from clinically suspected acute appendicitis

d is margin of error which is 5%

$$n = 1.96^2 \times 0.726 \times 0.274 / 0.05^2 = 306$$

Then using 10% non-respondent rate

The final sample size was 337

5.6. Sampling procedure

In this study all patients with clinical diagnosis of acute appendicitis who were visiting the radiology department for ultrasound evaluation in the study period were included.

5.7. Inclusion and exclusion criteria

5.7.1. Inclusion criteria

All patients who were clinically suspected of having acute appendicitis

5.7.2. Exclusion criteria

Patients who were operated only by clinical diagnosis of acute appendicitis without ultrasound evaluation

Patients who were diagnosed appendicitis by ultrasound and went home against medical advice.

5.8. Variables of the study

5.8.1. The independent variables

Age, sex, height, weight, Appendectomy, Appendicitis, Radiology resident, Radiologist, intern, GP, surgery resident, surgeon

5.8.2. The dependent variables

Percent of agreement of ultrasound and intraoperative finding in the diagnosis of acute appendicitis.

5.9. Operational definition

Positive appendectomy-when intraoperative findings showing inflamed appendix, phlegmon or perforated appendix with abscess collection.

Negative appendectomy-when there is no intraoperative findings suggestive of acute appendicitis as well as alternative findings.

We say the variables agree-when the Kappa value is greater than 0.5, we say moderate agreement when the value is between 0.5 and 0.7 and strong agreement is when the value is more than 0.7.

5.10. Data collection tools and procedures

Structured questionnaire was developed based on study objectives and available literature. Socio-demographic characteristics related to age, sex, and place of residents were properly recorded for each subject. The clinical signs and symptoms of the patients who were sent to the Radiology department with the clinical suspicion of acute appendicitis have been recorded. The ultrasound finding which was done by the hospital allocated radiologic resident or radiologist was collected. Finally the intraoperative findings of the patients who had surgical intervention for the diagnosis of acute appendicitis were recorded. Data have been collected using the data capturing sheet.

5.11. Data quality control

The hospital allocated Radiologic Resident, radiology technologist or Radiologist have done the ultrasound scanning. Completeness and consistency of the collected data have been checked on daily bases during data collection by the principal investigator. Whenever there appeared incompleteness and ambiguity of recording, the filled information formats have been cross checked with source data soon. Individual records with incomplete data were excluded. Data entry was done by standardized and consistent procedures with clear instructions to ensure data quality.

5.12. Data processing and analysis

Data have been entered using EpiData and send for analysis using SPSS version 24. Simple tabulation and descriptive statistics using cross tab and frequency table were used to look for the agreement of ultrasound finding of acute appendicitis with the intraoperative findings as well as the value of ultrasound for the diagnosis of acute appendicitis have been assessed. Correlation was used to look for the association of diagnostic ability of ultrasound for acute appendicitis with other variables that affect the ultrasound ability to diagnose acute appendicitis. Variables having p value less than 0.25 in bivariable linear regression analysis was added to final multivariable linear regression analytic process. Independent variables having a p value less than 0.05 in the analysis were considered as a significant association.

5.13. Ethical consideration

Before conducting the study, permission and approval letter from from TGSH hospital management and research review committee of Bahir Dar University College of medicine and health science have been received. Informed consent have been obtained before the imaging. The participants of the study were told they could discontinue whenever they want. During the data collection procedure, the patient privacy and confidentiality were kept to the maximum.

5.14. Dissemination of the research findings

Based on the findings, after conclusion and recommendation, one soft copy and two hard copy of the research paper will be submitted to Bahir Dar University College of medicine and health science. It will be presented to department of Radiology. The result will also be distributed to the library and department of surgery. Subsequently, attempts will be made to present it on scientific conferences and publish it on scientific journals.

6. Result

6.1. Sociodemographic data

A total of 337 subjects were studied with response rate of 100%. Males account 199 (59.1%) of the subjects. The study subject were in the age group of 2-66years with mean age of 25.14 years (SD 11.9 years).The majority of the respondents 233(69.1 %) were live in urban area. 186 (55.2 %) were single and 148 (43.9 %)were married, the rest are divorced. Majority 307 (91.1 %) of the respondents were Amhara in ethnicity. About 315 (93.5%) were follower of orthodox religion and 295 (87.5 %) were literate.

Table 1.Sociodemographic characteristics

Sociodemographic characteristics		Frequency	Percentage
Sex	Male	199	59.1
	Female	138	40.9
Religion	Orthodox	315	93.5
	Muslim	20	5.9
	Protestant	2	0.6
Educational status	Literate	295	87.5
	Illiterate	42	12.5
Residence	Urban	233	69.1
	Rural	104	30.9
Ethnicity	Amhara	307	91.1
	Agew	26	7.7
	Tigrie	3	0.9
	Others	1	0.3
Marital status	Single	186	55.2
	Married	148	43.9
	Divorced	3	0.9

6.2. Patient clinical presentation and laboratory findings

Among patients who were clinically suspected of acute appendicitis 98.8 % have abdominal pain, and rebound tenderness accounts 41.8% among the clinical presentation.

Table 2. Patient clinical presentations

Clinical presentations		Frequency	Percentage
Abdominal pain	Yes	333	98.8
	No	4	1.2
Nausea and vomiting	Yes	322	95.5
	No	15	4.5
Fever	Yes	196	58.2
	No	141	41.8
RLQ tenderness	Yes	291	86.4
	No	46	13.6
Rebound tenderness	Yes	141	41.8
	No	196	58.2
Leukocytosis	Yes	171	50.9
	No	165	49.1

From the clinical presentation for the diagnosis of acute appendicitis abdominal pain and right lower quadrant tenderness have sensitivity of 98% and 96.7% respectively. Fever and leukocytosis have specificity in the diagnosis of acute appendicitis with 64.7 and 58.8% respectively. When abdominal pain, right lower quadrant tenderness and fever are presenting symptoms in one patient the sensitivity and specificity of diagnosing acute appendicitis is 95.6% and 64.7% respectively.

6.3. Medical personnel who diagnose acute appendicitis clinically

Majority of the patients in our study were diagnosed clinically by medical interns (55.2%) and surgical residents (32%).

Table 3. Medical personnel who diagnose acute appendicitis clinically

Medical personnel who diagnose acute appendicitis clinically	Frequency	Percentage
Medical intern	186	55.2
Surgery resident	108	32
Surgeon	3	0.9
General practitioner	28	8.3
Others	12	3.6

6.4. Ultrasound findings

From a total of 337 clinically suspected acute appendicitis 164(48.4%) had positive ultrasound evidence of acute appendicitis.173 (51.6%) respondents have negative ultrasound finding for acute appendicitis, from these patients 76(22.6%) have normal ultrasound finding,22(6.5%) have mesenteric lymphadenitis, 16(4.7%) have renal stones,5 (1.5%) have PID and 6(1.8%) have ectopic pregnancy.

Enlarged appendix was found in 160(47.5%) of the patients who had positive ultrasound evidence of acute appendicitis while fecolith was found in 5(1.5%) patients. From ultrasound findings probe tenderness has sensitivity of 98.6%. Both non compressible appendix and enlarged appendix have sensitivity of 97.9%.Lymphadenopathy and fecolith have specificity of 19.2% and 3.4% respectively. In this study fecolith, increased periappendiceal fat echogenicity and increased appendiceal wall flow have specificity of 100% in the diagnosis of acute appendicitis.

Table 4. Ultrasound findings which suggest acute appendicitis

Ultrasound findings	Frequency	Percentage from total population
Enlarged appendix	160	47.5
Non compressible appendix	158	46.9
Probe tenderness	154	45.7

Increased appendiceal wall flow	89	26.4
Periappendiceal fat stranding	145	43
Periappendiceal fluid collection	83	24.6
Lymphadenopathy	30	8.9
Fecolith	5	1.5

Table 5. Alternative ultrasound findings

Ultrasound findings		Frequency	Percent
	mesenteric lymphadenitis	22	6.5
	renal stone	16	4.7
	PID	5	1.5
	ectopic pregnancy	6	1.8
	Other	48	14.2
	Total	173	51.3

6.5. Clinician who have done ultrasound

From the total 337 respondents 283(84%) ultrasound scanning is done by radiology residents and 51(15.1) is done by Radiologist.

Table 6.Clinician who have done ultrasound

		Frequency	Percent
	Radiologist	51	15.1
	Radiology resident	283	84.0
	Radiographer	3	.9
	Total	337	100.0

6.7. Intraoperative findings

Among 337 patients who were clinically suspected of having acute appendicitis 168(49.9%) patients were operated and 151(44.8%) were having intraoperative finding suggestive of acute appendicitis. Inflamed appendix and perforated appendix accounts 59.6% and 35.1% of intraoperative findings respectively. 17 patients who were operated have no intraoperative evidence of acute appendicitis, 9 of which were negative appendectomy and 6 of which were having ectopic pregnancy.

Table 7. Intraoperative findings which are suggestive of acute appendicitis

		Frequency	Percent
Intraoperative finding	inflamed appendix	90	59.6
	Phlegmon	5	3.3
	perforated appendix	53	35.1
	periappendiceal abscess	3	2.0
	Total	151	100.0

Table 8. Alternative intraoperative findings

		Frequency	Percent
Alternative intra OP findings	negative appendectomy	9	2.7
	ectopic pregnancy	6	1.8
	Other	2	.6
	Total	17	5.0

7. Agreement of ultrasound in the diagnosis of acute appendicitis with intraoperative finding

There is very good (strong) agreement between ultrasound finding and intraoperative finding with Kappa value of 0.822.

Table 9. Measure of agreement between ultrasound and intraoperative findings

Symmetric Measures

		Value	Asymptotic Standard Error ^a	Approximate T ^b	Approximate Significance
Measure of Agreement	Kappa	.822	.070	10.733	.000
N of Valid Cases		168			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

8. Sensitivity, specificity, accuracy, NPV, PPV of ultrasound in the diagnosis of acute appendicitis

Ultrasound has sensitivity, specificity and accuracy of 96.7%, 94.1%, 96.4% respectively with PPV and NPV of 99.3% and 76.2% respectively.

Table 10. Sensitivity, specificity, PPV and NPV of ultrasound in the diagnosis of acute appendicitis

Ultrasound finding suggestive of acute appendicitis * Intraoperative finding suggestive of acute appendicitis Crosstabulation

			Intraoperative finding suggestive of acute appendicitis		Total
			Yes	No	
Ultrasound finding suggestive of acute appendicitis	Yes	Count	146	1	147
		% within Ultrasound finding suggestive of acute appendicitis	99.3%	0.7%	100.0%
		% within Intraoperative finding suggestive of acute appendicitis	96.7%	5.9%	87.5%
	No	Count	5	16	21
		% within Ultrasound finding suggestive of acute appendicitis	23.8%	76.2%	100.0%
		% within Intraoperative finding suggestive of acute appendicitis	3.3%	94.1%	12.5%
Total	Count	151	17	168	
	% within Ultrasound finding suggestive of acute appendicitis	89.9%	10.1%	100.0%	
	% within Intraoperative finding suggestive of acute appendicitis	100.0%	100.0%	100.0%	

9. Associated factors

Using binary logistic regression significance for the model is seen and odds ratio is calculated for variables that affect the agreement of ultrasound and intraoperative findings.

Gender is significance predictor of agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis with ($p= 0.001, B=2.489$) and Odd ratio of 12.045. Being male has 12.045 times more being acute appendicitis than females who had ultrasound scanning.

Clinician who have done ultrasound represented by two dummy variables using Radiologist used as a comparison variable. There is a negative coefficient in both variables suggesting that ultrasound done by radiology resident and radiographer is less likely to be acute appendicitis than done by radiologist. Ultrasound done by radiology resident is 0.22 times less being acute appendicitis than ultrasound done by radiologist ($B=-3.829, SE=1.667, p=0.022$) and ultrasound done by radiographer is 0.21 times less being acute appendicitis than ultrasound done by radiologist ($B=-3.337, SE=1.667, p=0.021$).

Table 11. Odds ratio of the variables in Binary logistic regression

Variables	Coef (B)	S.E	Odds ratio(Exp (B))	95% CI		p-value
				Lower	upper	
Sex						
Females			1			0.001
Males	2.489	0.777	12.045	2.625	55.266	0.001
Clinician who have done ultrasound						
Radiologist			1			0.53
Radiology resident	-3.829	1.667	0.22	0.001	0.57	0.022
Radiographer	-3.337	2.834	0.21	0.001	0.482	0.021

10. Discussion

Among imaging methods currently used in the clinical practice, ultrasound is a valuable tool. This noninvasive option is repeatable, avoids the exposure to nonionizing radiation and can be less expensive as compared to CT costs. In many part of Ethiopia where other diagnostic tools are deficient ultrasound may be the only diagnostic modality.

In our study there is very good (strong) agreement between ultrasound finding and intraoperative finding with Kappa value of 0.822(95% CI). This finding is similar with a cross sectional study done in Darfur, Sudan on the role of ultrasound for evaluation of acute appendicitis to evaluate the accuracy of ultrasound as compared with the operative findings on 51 patients which showed a good agreement between sonographic and surgical findings, which was statistically significant ($\kappa=0.70$ [95% CI, 0.49–0.91])(22).

Our study showed the sensitivity, specificity and accuracy of ultrasound in the diagnosis of acute appendicitis is 96.7%, 94.1% and 96.4% respectively with positive predictive value of 99.3% and negative predictive value of 76.2%. Most of the study done showed lower sensitivity and specificity than in our study, but a prospective study done on abdominal sonography screening in clinically diagnosed of acute appendicitis to assess the need of ultrasound in Taiwan, China found that abdominal sonography for detecting acute appendicitis had a sensitivity of 99.3%, a specificity of 68.1%, a positive predictive value of 90.5%, and a negative predictive value of 97.0%(23), in this study the sensitivity and NPV were higher than in our study but the specificity and PPV were lower than in our study. In a prospective institutional based study done in Tikur Anbesa Hospital, Ethiopia on 194 patients with suspected of acute appendicitis to assess the sensitivity, specificity of ultrasound for the diagnosis of acute appendicitis, the sensitivity of US in diagnosing acute appendicitis was found to be 87.9% with specificity of 86.5% (16) which has also lower sensitivity and specificity than in our study. The reason behind higher sensitivity and specificity of ultrasound in the diagnosis of acute appendicitis in our study may be patient with acute appendicitis comes late so that it may increase the ability of ultrasound to detect signs of appendicitis. The other reason is in our study we use postoperative result as a gold standard but in other study the pathology from the intraoperative finding was used this may increase sensitivity and specificity in our study.

Gender is significance predictor of agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis with ($p= 0.001, B=2.489$) and Odd ratio of 12.045. Being male has 12.045 times more being acute appendicitis than being females who had ultrasound scanning. This is similar with a study done in Palestine on 180 patients who are clinically diagnosed with appendicitis on the sensitivity and specificity of ultrasound for the diagnosis of acute appendicitis which showed a significantly higher false diagnosis rate in female patients than in males(26).

In our study clinician who has done ultrasound is significant predictor of agreement of ultrasound and intraoperative findings in the diagnosis of acute appendicitis. Ultrasound done by

radiology resident is 0.22 times less being acute appendicitis than ultrasound done by radiologist (B=-3.829, SE=1.667, p=0.022) and ultrasound done by radiographer is 0.21 times less being acute appendicitis than ultrasound done by radiologist (B=-3.337, SE=1.667, p=0.021).

In our study from 337 patients who are clinically suspected of acute appendicitis there were 97 patients who have alternative diagnosis by ultrasound. Mesenteric lymphadenitis, renal stone, PID, ectopic pregnancy and other miscellaneous disease accounts the alternative diagnosis in decreasing order. A prospective study done in Norway on 240 patients with clinical diagnosis of acute appendicitis on the diagnostic accuracy of high resolution ultrasound for the diagnosis of acute appendicitis shows Lymphoid hyperplasia in a patient with terminal ileitis, ulcerative colitis, mesenteric lymphadenitis and gynecological disorders (tubal pregnancy and ruptured corpus luteum cyst), in their decreasing order, contribute for false positive results(4). Another prospective study done in Netherland, on the importance of ultrasound in the diagnosis of acute appendicitis on 525 patients with clinical signs of acute appendicitis found alternative diagnosis with decreasing in frequency are bacterial ileocaecitis, mesenteric lymphadenitis, gynaecological conditions, urological conditions, caecal diverticulitis, perforatedpeptic ulcer, Crohn's disease and miscellaneous conditions (13).In these two studies we can see almost similar disease groups that mimic acute appendicitis but with different frequencies to our study result. This difference can be explained by difference in disease prevalence.

11. Conclusion

There is very good (strong) agreement between ultrasound and intraoperative finding in the diagnosis of acute appendicitis.

The sensitivity, specificity and accuracy of ultrasound in the diagnosis of acute appendicitis is 96.7%, 94.1% and 96.4% respectively with positive predictive value of 99.3% and negative predictive value of 76.2%.This is higher than in most of the standard text books.

Gender and the qualification of personnel who has done ultrasound are significant predictors of agreement of ultrasound and intraoperative findings of acute appendicitis. Being female increase likelihood of being negative appendicitis and ultrasound done by radiologist is more likely be positive than done by radiology resident and radiographer.

Mesenteric lymphadenitis, renal stone, PID, ectopic pregnancy and other miscellaneous disease are the alternative diagnosis by ultrasound in decreasing order.

12. Recommendation

To hospital staff and both radiology and surgery departments

We recommend the surgical department strongly consider ultrasound for the diagnosis of acute appendicitis prior to operation to reduce unnecessary operation.

We recommend the radiology department to give special attention while scanning female patients to avoid false negative and positive results.

We recommend consultation for Radiologist should be encouraged to reduce negative appendectomy.

To regional and federal administrative

We recommend the regional health beauro and ministry of health to facilitate diagnostic ultrasound facility to the level of primary hospital to avoid unnecessary operation for acute appendicitis.

To the researchers

We recommend further research with large population, long study period and using pathology result as a gold standard.

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