

CORRELATION OF ULTRASOUND, CLINICAL AND SURGICAL FINDINGS OF SUSPECTED ACUTE APPENDICITIS IN KENYATTA NATIONAL HOSPITAL.

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ABSTRACT

Background: Acute appendicitis is the most common surgical abdominal emergency with a life time prevalence of one in seven ⁽¹⁾. The incidence rate of acute appendicitis is approximately 1 in 400 (0.25%) and the prevalence of 7% to 8% in United States of America (USA) ⁽²⁾

Acute appendicitis continues to provide a diagnostic challenge to clinicians today resulting in an increased demand for ultrasonographic evaluation of patients suspected of having acute appendicitis. Misdiagnosis is not uncommon.

The lack of statistically tested results of the accuracy of ultrasound in the evaluation of acute appendicitis in Kenyatta National Hospital prompted this study.

Objective: The main objective of the study was to investigate the role of ultrasonography in establishing diagnosis in patients with clinical suspicion of acute appendicitis.

Methodology: A prospective study was carried out at Kenyatta National Hospital (KNH) within a period of six months at Radiology department.

Patients suspected to have acute appendicitis on the basis of history and clinical examination underwent abdominal ultrasonography using high frequency linear probes. The patients were then followed up at the surgical department and the theatre findings determined.

Data collection sheets were used to record the demographic information, the clinical information, ultrasound findings and surgical findings. This data was analyzed using computer software and the results presented in form of tables, charts and graphs.

Results: A total of 112 patients operated between March to November 2010 were studied, 73 patients were males and 39 females, giving a male to female ratio of 1.9:1. The age of patients ranged from 8years to 70years. All patients presented with abdominal pain (100%) which was localized at right iliac fossa in 96(86%) patients and in 16 (14%) patients the pain was generalized. The abdominal pain was associated with vomiting and fever in 75 (67%) and 66 (57%) patients respectively. Majority 111(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 RIF maximum tenderness, 64 had blinded ending tubular structure of diameter of 6mm or larger, 39 had fluid at RIF and echogenic peri-appendiceal fat in 25 patients. The rest (15) patients had normal sonographic features. All patients underwent appendectomy and 61(54.5%) had inflamed appendices, 32(28.6%) perforated appendices, 27(24.1%) abscess and 5(4.5%) were gangrenous. The histology 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. Only 12 patients out of the total 112 had normal appendices on histology giving an overall negative appendectomy rate of 10.7%. This finding is similar to what was reported by Mohammed Akbar Mardan and Stefan Puig ^(12, 19) in which 9.8% of patients who underwent preoperative US resulted in negative appendectomy.

Conclusions: Ultrasound by graded compression technique is a useful adjuvant to the clinical diagnosis of acute appendicitis. It can reduce the negative appendectomy 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%). A high clinical suspicion is still of paramount important in the management of acute appendicitis

INTRODUCTION

Acute appendicitis is the most common surgical abdominal emergency with a life time prevalence of one in seven ⁽¹⁾. The incidence rate of acute appendicitis is approximately 1 in 400 (0.25%) and the prevalence is 7% to 8% in United States of America USA. In Kenya the number of cases per annum is 82,455 which give an incidence of approximately 0.25%. The incidence of appendicitis is approximately 1.4 times greater in men than in women ⁽²⁾.

The diagnosis of acute appendicitis is mainly clinical but because of its myriad presentation, this diagnosis is correct in up to 80% of the patients ⁽³⁾. As the consequences of missed diagnosis are dire, the common surgical practice has been to operate on doubtful cases rather than to wait and see until the diagnosis is certain. This has resulted in a negative appendicectomy rate of 20 to 30% which has been considered acceptable ⁽⁴⁾.

However this acceptance has being challenged at present day of quality assurance. The removal of a normal appendix is not a benign procedure and negative appendicectomy carries a definitive morbidity. Today's health conscious patient is also concerned about the removal of his normal appendix ⁽⁵⁾. The presence of many organized lymphoid aggregations suggests an immunological role to the appendix. Ironically, these lymphocytes may account for the profound inflammatory changes seen with acute appendicitis. However, of note is that, the removal of the appendix does not seem to present any functional loss for the individual's digestive or immune system ⁽⁶⁾.

In order to improve the diagnostic accuracy, different aids have been introduced like computer aided programs, different scoring systems, gastrointestinal tract contrast studies, Computer tomography scan (CT Scan), Ultrasonography and Magnetic resonance imaging (MRI) ⁽⁷⁾.

Among the imaging modalities, Ultrasonography is the simplest, easily available, noninvasive, convenient and most cost effective technique ⁽⁸⁾.

The ultrasound in the diagnosis of acute appendicitis was first popularized by Puylaert in 1986, one hundred years after the publication of first paper on acute appendicitis by Fitz ⁽⁹⁾. In the graded compression technique, where a gradually increasing pressure is applied to the right iliac fossa by a hand held ultrasound (US) transducer, normal and gas filled loops of intestine are

either displaced from the field of vision or compressed between anterior and posterior abdominal walls ^(9, 10).

The inflamed appendix being incompressible is thus optimally seen as a blind ended tubular structure with laminated wall arising from the base of the caecum. It is aperistaltic, noncompressible and its diameter should be more than 6mm. Appendicoliths appear as bright echogenic foci with distal acoustic shadowing, and their visualization is another contributory finding toward the diagnosis of acute appendicitis. There may be increased echogenicity of the periappendiceal fat ^(9, 10).

Puylaert (1986) reported the sensitivity of 89% and specificity of 100% of ultrasound graded compression technique in the diagnosis of acute appendicitis ⁽¹⁰⁾.

The aim of this study is to evaluate the role of ultrasonography in establishing the diagnosis of acute appendicitis in patients with clinical suspicion of acute appendicitis locally and to compare these finding with studies done elsewhere.

Material and Method

Study design:

Prospective descriptive study

Study area:

This study was carried out at Kenyatta National Hospital (KNH) which is one of the largest referral, teaching and research hospital in Kenya and sub-Saharan Africa.

The study was conducted at Radiology department of KNH which is well equipped with modern ultrasound machines including volumetric and endocavitary scanning. Patients were followed up to the surgical department and the theatre findings determined.

Study population:

This included all patients suspected to have Acute appendicitis on the basis of history and clinical examination, who were referred from emergency casualty and surgical ward for abdominal US and there after taken to theatre for laparotomy and who consent to be included into the study.

Study period:

The study was conducted from March 2010 to November 2010 at KNH. It included all patients who meet the following eligibility criteria.

Eligibility criteria:

All patients who attended at KNH with suspected acute appendicitis within the study period.

Inclusion criteria:

All patients with clinically suspected acute appendicitis, who with US as part of investigation and subsequently underwent laparotomy, were included in this study.

Exclusion criteria:

All patients who did not underwent surgery.

Patients who did not underwent Ultrasound examination.

All non-consenting patients.

Sample size:

The sample size included patients attending at Kenyatta National Hospital with suspected acute appendicitis (with eligibility criteria) from March to November 2010. The sample size was determined by the following formula by Fisher et al (1998) ⁽⁴⁵⁾

$$N = \frac{p(1-p)z^2}{d^2}$$

Where:

N= sample size

Z= standard error corresponding to 1.96

d= absolute precision (5%)

P= prevalence of acute appendicitis is 7%. ⁽²⁾

The calculated minimal sample size was **100** patients

$$N = \frac{0.07(1-0.07)(1.96)(1.96)}{(0.05)(0.05)} \quad N = 100$$

Equipment:

Patients were scanned using (real time) Philips ultrasound machine (model SD 800), a LOGIC 7 from healthcare at KNH, and a Hewlett Packard Image Point HX machine and G.E Logic 5 Expert machine at Department of diagnostic Radiology University of Nairobi.

All the above listed machines contain standard multiple frequency probes (3.5 MHz- 11 MHz) including color Doppler and power Doppler facilities.

Preparation and Technique

No prior patient preparation was required for abdominal ultrasound for acute appendicitis

The patient was laid on supine position and ultrasound transducer was used to apply graded compression at the right lower quadrant of the abdomen. This displaced bowel loops and compresses the caecum. Images obtained using the above equipments followed standard ultrasound abdominal protocols. The image acquisition and quality was made uniform for all patients regardless of the equipment. High definition sonographic imaging equipment was used.

The Ultrasonographic findings for acute appendicitis were:

Visualization of noncompressible tubular and blind-ended aperistaltic structure with diameter greater than 6 mm in the right iliac fosse. The demonstration of appendicoliths, probe tenderness, increased echogenicity of the periappendiceal fat, free intraperitoneal fluid particularly in RIF or pelvis and circumferential color on Doppler ultrasound were additional collaborative data for positive criteria in acute appendicitis.

Standardization of result:

Sonography was done by the principal investigator under supervision by consultant radiologists. The sonographic finding found was recorded in consultation with the consultant radiologists in study questionnaire.

Surgery was done by postgraduate students and consultant surgeons of surgical department and the surgical findings were obtained from the theatre notes.

Study Limitations:

US is operator dependent

The patient's physique (obesity)

Excessive bowel gas can mask the appendix

Retrocecal location of appendix limits its visualization by ultrasonography.

Data collection and analysis:

This was done by the researcher using a data collection form.

The data collection form comprised of a section on patient's sociodemographic characteristics, clinical findings, US finding and surgical findings during operation.

Analysis was carried out using SPSS computer package.

The data acquired was presented in form of tables and graphs.

To determine the correlation, cross tabulations between US findings, clinical finding and surgical findings was done.

RESULTS:

A total of 112 patients were analyzed. Seventy three (65.2%) were males and 39(34.8%) females with M: F ratio of 1.9:1. The age range of the 112 patients included in this study was 8 to 70 years. The majority (37.5%) were aged between 20 and 29 years and the least frequent age group being less than 10 years at 4.5% of the total patients attended.

All (100%) patients presented with abdominal pain of which in 96 (86%) the pain was localized at the RIF and 16 (14%) was generalized. Vomiting and fever were present in 67% and 59% of the patient respectively. Abdominal tenderness/guarding (99%) was the most common clinical sign elicited followed by rebound tenderness (78%).

Majority (92%) of the female patients had abdominal pain at the RIF compared to the male (82%). 70% of the male patients (51 of 73 patients) presented with vomiting compared to females 62% (24 of 39 patients). Nausea was equally present in both sexes (49%).

Majority of patients suspected to have acute appendicitis had Maximal tenderness at RIF (68%) followed by Blind ending tubular structure, RIF Fluid/Abscess and High echogenic surrounding

fat at 60%, 34.8% and 22.3% respectively during sonographic examination. The least common finding was oedema of the ceecal pole 4.5%

On Surgery most of the appendices were inflamed at 54.5%, followed by perforated appendix (28.6%) abscess (24.1%) and the least frequent surgical finding was Gangrenous appendix at 5%.

Majority of the histological findings confirmed the diagnosis of acute appendicitis at 89.3%.

Among the patients with sonographic features of tubular blind ending structure, 59(88%) presented with right iliac fossa pain followed by vomiting 53(79%) and fever 42(63%). Abdominal tenderness and rebound tenderness was the most frequent clinical sign detected among the patients with tubular blind ended structure at 66(98%) and 55(82%) respectively.

Among the blind ending tubular structure most of them were found to be inflamed at surgery (34 out of 67 patients or 51%). 53% of the patients who had maximal RIF tenderness during sonography also showed inflamed appendix at surgery (41 out of 76).

Among the 32 patients with perforated appendix 20 (62.5%) of them presented with tubular blind ending structure during sonographic examination.

61 out of 67 patients who demonstrated blind ended tubular structure on sonography were confirmed to have acute appendicitis on histology. The least predictive sonographic features for acute appendicitis on histology were maximal tenderness at McBurney's area.

All patients found to have perforated (32) and gangrenous (5) appendix intra-operatively were confirmed to have acute appendicitis on histology. About 8(13%) of the inflamed appendix at surgery was found to be normal on histology.

There is a significant association between diameter of appendix on ultrasound examination and the histological finding (p-value <0.05). Patients with diameter of appendix of 6mm or more sonographically are more likely to have acute appendicitis at histology.

The sensitivity and positive predictive value of US finding when compared to surgery is high but the specificity and NPV is very poor. There were 10 out of 97 patients who had false positive diagnosis of acute appendicitis.

Among the female patients the majority 37(95%) were found to have acute appendicitis both on ultrasound and in histological examination. Negative appendicectomy among female patients was 5% (2 of 39 patients) while for the male patients it was 13.7% (10 of 73 patients) on histology. However these findings are not statistically significant.

Among 97 patients with suggestive features of acute appendicitis on ultrasound, 92 proved positive on histology. 7 appendices were negative on both ultrasound and histology. There were 8 patients who reported false negative on ultrasound. Therefore Sensitivity= 92%, specificity = 58.3%, PPV= 95%, NPV =47% Accuracy =88.4%. P-value < 0.05

Among 99 patients with diagnosis of acute appendicitis intraoperative, 91 proved positive on histology. 4 appendices were negative on both intraoperative and histology. There were 9 patients who reported false negative on intraoperative. Therefore Sensitivity= 91%, specificity = 33.3%, PPV= 92%, NPV =31% Accuracy =85%. P-value 0.033

DISCUSSION

Acute appendicitis is a clinical condition which needs surgical treatment as soon as possible. If ignored it may get complicated and increase the morbidity and mortality.

Majority of patients in this study were aged between 20 and 29 Years (Table 4.1), which correlates with study done by Mohammed and Kalantar.^(14, 46) In this study the overall male to female ratio was found to be 1.9:1. However at the 20-29 age groups the male: female ratio was 1:1.7. This finding is similar to a previous local study which was done by Wilmore and Dr Kavoo Kalonzo⁽⁴⁷⁾ who found the overall male: female ratio of 1.8:1.

Abdominal pain is the most common symptom of appendicitis. This was found in all 112(100%) patients. Majority 96(86%) of patients had localized pain in the right lower quadrant of abdomen and only 16(14%) had generalized abdominal pain. 75(67%) of the patients had vomiting (Figure 4.2). This correlates with a study done in 2008 by Bashir A.S.⁴¹ which showed that abdominal pain was the most common symptom of acute appendicitis at 98%.

Fever which is also an important and prevalent symptom in acute appendicitis, was found in 66(59%) of the patients in this study. This finding is contrary to what were found in previous studies where 33 - 37% of patients with fever. ^(35, 41) The High percentage of patients with fever in this study could be related to the complications of acute appendicitis as the majority of the patients (57%) presented with complications of acute appendicitis (perforation, gangrenous and abscess formation) which was not seen in the earlier studies.

Majority 111(99.1%) of the patients in this study had abdominal tenderness (Figure 4.2). These findings correlate with study done by Bashir A.S ⁽⁴¹⁾ which showed abdominal tenderness was elicited in 98.27% of the patients.

Acute appendicitis is a clinical diagnosis and no laboratory or radiological tests are 100% accurate. In equivocal and difficult cases of acute appendicitis ultrasound examination of the abdomen and pelvis is usually recommended. ^(6, 12, 13)

In this study, ultrasound was performed in 112 patients. In 67(59.8%) patients, appendices were visualized as a blind ending tubular structure which was non compressible, aperistaltic with diameters ranging from 4.9mm to 26mm. The diagnosis of acute appendicitis was more likely when the diameter of appendix is 6mm or more. 64 out of 67 (95.5%) appendices with diameter of 6mm or more were positive for acute appendicitis and only 3 appendices had diameter of less than 6mm. These were negative for acute appendicitis. Therefore the sensitivity, specificity, PPV and NPV of diagnosis of acute appendicitis using diameter of appendix was 100 %.(Table 4.8) From literature many authors' have shown similar findings. ^(6, 23, 25)

In this study other sonographic findings which aided in the diagnosis of acute appendicitis included maximum tenderness at RIF when compressed by the probe in 76 (68%) patients, 39(35%) had RIF fluid/abscesses and 25(22%) had high echogenic periappendiceal fats. These results show that in the diagnosis of acute appendicitis using ultrasound, there are usually more than one parameters where the appendix is not visualized (Table 4.3). These findings were also seen by Bashir A.S. in Pakistan.⁴¹ which showed that 62% of patients had findings suggestive of appendicitis, that is fluid around the appendices and echogenic periappendiceal fat, 12% of the patients had appendicular mass.

This study has shown that circumferential increased colour flow Doppler occurred in 22 appendices out of 97 patients with sonographic suspicion of acute appendicitis. 21 out of 22 appendices were confirmed to have acute appendicitis on histology giving a positive predictive value of 95.4% (Table 4.6). Colour Doppler ultrasound is very useful in detecting inflamed appendix however its sensitivity in complicated appendices is relatively low. These findings were also seen 2007 by Diana Gaitini in Israel ⁽²⁵⁾ which showed that, colour Doppler sonography for acute appendicitis had high positive predictive value of 88%.

Clinical findings were found to correlate with the sonographic findings for most of the patients who presented with symptoms and signs of acute appendicitis. Majority of the patients with blind ending tubular structure presented with RIF pain in 88% (59 out of 67), followed by vomiting 79% and fever 63%. Abdominal tenderness and rebound tenderness were the most frequent clinical signs detected in the patients with tubular blinded end structure at 66(98%) and 55(82%) respectively (Table 4.4). Similar findings were observed by J. R. Brook and others in San Francisco General Hospital and they concluded that diagnosis of acute appendicitis can be diagnosed in adult with RIF pain and a visualized appendix with diameter of 6mm or more ^(21, 26).

Open appendicectomy has been the standard treatment for decades with excellent results for more than a century since its introduction by McBurney's in 1894.³⁹ Open appendicectomy was performed in all 112 patients who underwent sonographic diagnosis of acute appendicitis in this study. The excised appendix was then sent for histological confirmation. However intra-operatively 99 (88.4%) of the appendices were identified as acute appendicitis. Of these 54.5 % (61 of 99) had simple appendicitis, 37(33%) complicated appendicitis (perforated and gangrenous) and 27 (24.1%) RIF and pelvic abscesses (Table 4.3). These findings are similar to observations done 2006 by Mughal and Bashir A. Soomro ⁽⁴¹⁾ which showed that 53.4% of patients had simple acute appendicitis, 44.8% complicated appendices.

Other intra operative per-appendiceal findings which mimicked acute appendicitis clinically in this study included 5 cases of tubo-ovarian complex, 4 cases of peritoneal adhesions secondary to previous laparotomy, 4 cases of mesenteric adenitis and a single case of Meckel's diverticulitis and typhoid enteritis (Table 4.3). These findings were similar to what was published in 2007 by Diana

Gaitini ⁽²⁵⁾. She found that gynecological disorders, mesenteric lymphadenitis, cholecystitis and hydronephrosis were alternative intraoperative findings.

Historically, the accepted negative appendectomy rate has been about 20%. Preoperative imaging has been widely adopted as a means of improving the accuracy of diagnosing appendicitis and therefore reducing negative appendectomy rates (NAR) and perforation rates²⁰. This positive impact of pre-operative sonography has been shown in this study where out of 112 appendectomies performed only 12 patients had normal appendices on histology giving an overall negative appendectomy rate of 10.7%. This finding is similar to what was reported by Mohammed Akbar Mardan and Stefan Puig ^(12, 19) in which 9.8% of patients who underwent preoperative US resulted in negative appendectomy.

This study has further shown that female have significantly lower negative appendectomy rate (NAR) of 5% compared to the male counterpart which was 13.3% (10 of 73) (Table 4.10). This is comparable to a study done in 2002 by Sandra E.B and Matilde ⁽²³⁾ which reported lower rate of negative appendectomy (8%) among women patients who underwent pre-operative ultrasound examination for acute appendicitis.

After the pioneer article of Puylaert in 1986, a number of workers have studied the role of ultrasound in management of suspected acute appendicitis. Most of these authors had shown reports of increased diagnostic accuracy when ultrasound was added to the clinical work up of the patients. ^(6, 10, 18, 29) Ultrasound has been reported to be most helpful in clinically equivocal cases because of false positive and false negative results. In this study, the sensitivity, positive predictive value and accuracy of US for the diagnosis of acute appendicitis are 92% (92 of 100 examinations), 95% (92 of 97 examinations) and 88.4% respectively (Table 4.11). These findings were also seen by many investigators ^(8, 13, 14, 15, 25, and 28). However this study shows low specificity (58%) and low negative predictive value (47%) which correlates with the findings of Mufti T.S et al¹¹.

There are certain draw backs in the sonography for acute appendicitis which may have contributed to the low specificity (58%) and low negative predictive value (NPV) (47%) in this study. The foremost important is the experience of the radiologist, as the procedure is highly operator dependant as well patient's habitus and physical conditions. There are reports in the literature against the usefulness of ultrasound in diagnosis of acute appendicitis. Operator

dependency of the technique may also be the reason for these reports with poor outcome. In one such report from a similar setting Mufti TS et al⁽¹¹⁾ concluded that the use of graded compression ultrasonography as a preoperative diagnostic technique had a good sensitivity (84.3. % and 81.81 %), but poor specificity implying that value of ultrasonography may remain unclear in reducing the negative appendicectomies.

Secondly, this study was based on patients with clinical suspicion of acute appendicitis who underwent abdominal sonographic examination followed by appendectomy. Those patients with negative sonographic finding and alternatives diagnoses were not operated and consequently were not included in the study which might have contributed to the low specificity and NPV.

An important advantage of ultrasound in acute appendicitis is the diagnosis of alternative conditions that may mimic acute appendicitis⁽³⁰⁾. Most of these conditions did not require surgery, were referred to gynecologist and therefore were excluded from the study (cf exclusion criteria).

In conclusion 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 the NPV is quite high.

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