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Role of ultrasound in the diagnosis of acute appendicitis: A prospective study

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Abstract

Background and Aim: Although the clinical presentation of acute appendicitis is typical in 70% of the cases, about 30% of the patients have an uncertain pre-operative diagnosis. Consequently the rate of unnecessary laparotomy is as high as 20-25%. The aim of the study was, to evaluate the role of ultrasound in the diagnosis of acute appendicitis in clinically equivocal cases.

Materials and Methods: 100 patients clinically suspected to be acute appendicitis were referred for ultrasound examination. Presence of appendicoliths, loculated collections, complex masses in the right iliac fossa were also considered in the diagnosis of acute appendicitis. The sonological findings were correlated with surgical findings. In patients, who had negative graded compression US examination, abdomen and pelvis were assessed with curvilinear transducer of 3.5-7.0MHz

Results: Of the 100 patients who formed the study population, 76 patients had acute appendicitis. Ultrasound was sensitive in detecting acute appendicitis in 66 patients. 10 patients were falsely diagnosed as acute appendicitis on ultrasound. One patient was false positively diagnosed as having acute appendicitis. US could detect normal appendix in 8 cases. Ultrasound provided alternate diagnosis in 6 patients, thus influencing the management. The overall accuracy of ultrasound in the diagnosis of acute appendicitis was 86.36%. The sensitivity, specificity, predictive value of a positive test and predictive value of a negative test were 86.64%, 83.33%, 97.05% and 50% respectively.

Conclusion: Ultrasound being non-invasive, non-traumatic, readily available modality is a result-oriented examination in clinically equivocal cases of acute appendicitis.

Keywords: Acute appendicitis, ultrasound, graded compression, non-compressible

Introduction

The appendix is a pouch-like structure attached at the start of the large intestine that has no known purpose. Appendicitis begins with fever and pain near the belly button and then moves toward the lower-right side of the abdomen. This is often accompanied by nausea, vomiting, loss of appetite, fever and chills ^[1]. Appendicitis is usually treated with antibiotics and surgery is required within 24 hours of its diagnosis. If untreated, the appendix can rupture and cause an abscess or systemic infection. Acute appendicitis is the most common cause of acute abdomen. Although the clinical presentation of acute appendicitis is typical in 70% of the cases, about 30% of the patients have an uncertain pre-operative diagnosis ^[2, 3].

Plain film diagnosis depending on the occasional demonstration of appendicoliths or ureteric calculus is neither sensitive nor specific. The diagnosis of acute appendicitis by the barium enema studies is mainly based on the demonstration of non-filling of the appendix. It is not frequently used and it has an accuracy that ranges from 50-85% ^[4]. White cell and anti-granulocyte scintigraphic scans have also been used in the diagnosis of right lower quadrant pain, but are expensive, time consuming and are not very sensitive ^[4, 5]. Computed tomography is considered to be sensitive and specific for the diagnosis of acute appendicitis, but the thin sections that often necessitates a more focused examination increases the possibility of missing pathology outside the field of view. It is a relatively expensive test that often requires introduction of oral and intravenous contrast agents ^[6]. Besides CT is neither sensitive nor specific for the diagnosis of gynaecologic disease, a frequent mimicker of acute appendicitis ^[7]. Ultrasound has also been shown to be highly sensitive and specific for the diagnosis of not only acute appendicitis but also other conditions that cause right lower quadrant pain. It is crucial to avoid two potential situations in patients with suspected AA: ^[1] any delay in diagnosis and subsequent perforation of the appendix; ^[2] an unnecessary appendectomy.

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There is agreement that imaging techniques improve both of these clinical scenarios, due to the potential for early diagnosis and the high sensitivities (CT, MRI) and specificities (US, CT, MRI) of these techniques. In many centres, sonography has become the procedure of choice for the initial evaluation of acute appendicitis with equivocal clinical features, particularly in paediatric and women of childbearing age group. Very few studies have been conducted in our part of the country and sufficient data was not available regarding the role of sonography in the evaluation of clinically suspected cases of appendicitis. We conducted this study thus enabling in avoiding unnecessary negative laparotomies.

Materials & Methods

Type of study

The present study was a non-randomized, prospective study.

Source of data

Data for the study was collected from the patients attending Department of Radio-diagnosis, clinically suspected to be having acute appendicitis.

Ethical committee clearance

Ethical committee of Medical College approved the present study.

Study pattern

100 patients who reported to the surgical OPD or emergency Department with history of abdominal pain in whom the clinical signs were equivocal for acute appendicitis were referred to our department for ultrasound evaluation. After the sonographic examination, the results were compared with operative findings.

Maintenance of records and collection of data

All the observations during the study of each subject were recorded in an individual case proforma (CP) signed by the investigator. The CP contained all information regarding the admission details, general particulars like name, age, sex and address, clinical history of the patients, general examination which included pulse, temperature, at the time of examination physical examination details, investigations-WBC count and ultrasound examination, operative findings, final histopathology report. The principal investigator maintained the entire record.

Selection criteria

Inclusion criteria

1. Patients clinically suspected to be having acute appendicitis.
2. All individuals irrespective of age and sex.
3. Cases with history of recurrent appendicitis presenting with acute symptoms were included.
4. Cases of acute appendicitis with early pregnancy were also included in this study.

Exclusion criteria

1. All other causes of acute abdomen.
2. Cases with recurrent appendicitis not presenting with acute symptoms.
3. Cases of acute appendicitis diagnosed clinically and sonologically but not willing for further management were excluded from the study.

Sonological equipment used

ESOATE AU-5 with multi-frequency linear array transducer (7.5MHz-10.0MHz) and curvilinear transducer (3.5MHz-7.0MHz) was used for our study.

Method of Examination

All US studies were performed with the 7.5-10.0MHz linear array transducer. In women a US study of the pelvis was acquired with 3.5MHz-7.0MHz curvilinear transducer with the patient's bladder partially filled. By using a linear array transducer the sonographic plane was perpendicular to the table, the special flat T-shape enabled the examiner to exert gentle compression with the transducer using both hands in the same way as when palpating the abdomen. The method of examination in this study was similar to that used in the graded compression described by Puylaert. Before the study, all patients were asked to point to the site of maximal pain in the right lower quadrant (RLQ) with a single finger. The examination was initiated by scanning in the transverse plane in the lateral right mid abdomen just above the level of umbilicus. The examination was continued caudally in the RLQ with gradually increasing compression until all bowel gas and fluid could be expressed from the ascending colon and caecum. An attempt was made to image caecal tip in the transverse plane by scanning caudal to the approximate insertion of the terminal ileum. Gently reducing and then increasing the pressure of the transducer allowed assessment of compressibility of the normal bowel, normal caecum and terminal ileum. Care was taken so that pressure on the transducer was gradually reduced so as not to elicit pain because of rebound tenderness. The inflamed appendix was most often visualized at the base of caecal tip during maximal graded compression. The examination was continued caudally with identification of the psoas and external iliac artery and vein. Longitudinal and oblique scans were then obtained of the lower quadrant again with graded compression. Measuring the distance from one point on the serosal layer to opposite point on serosa assessed outer diameter. The examination was considered diagnostic if all the bowel gas and fluid could be manually expressed with the transducer from the caecum and terminal ileum. A study was non-diagnostic if the caecum could not be adequately compressed. In women the pelvis was imaged in the longitudinal and transverse planes with the patient's bladder partially filled.

Sonological criteria for acute appendicitis

- A. Eliciting sonographic McBurney's point tenderness
- B. Blind ending immobile, no compressible tubular structure in the right iliac fossa
- C. Bull's eye or target lesion with diameter of >6.0mm
- D. Presence of appendicoliths
- E. Complex appendiceal mass or abscess
- F. Other associated findings like integrity of the sub mucosal layer, peri appendiceal fluid collection, pericaecal-increased echogenicity, hypo/hyper peristaltic loops in the right iliac fossa, enlarged mesenteric lymph nodes.

Clinico-sonological correlation

Following surgery of the recruited patient the operative notes recorded by the operating surgeon mentioning the condition, position, and other associated features of the appendix (faecolith, loculated collection, mass formation)

were correlated with that of sonological features noticed on ultrasound examination prior to surgery. Sonographic visualization of inflamed appendix or identification of peri appendiceal abscess was considered positive for the diagnosis of appendicitis. Visualization of appendix less than 6mm or non-visualization was recorded as negative result. If the inflamed appendix could be identified, the largest outer diameter was measured using electronic callipers. A histopathological examination was performed on all surgically removed appendices, which formed the basis for definitive judgement. Diagnoses in patients not undergoing surgery were verified by evaluating all examinations, including follow up observations.

Result

Age incidence: Varied between 1st to 8th decades of life. The peak incidence of 48% was found to be in the age group of 21-30 yrs. The youngest patient treated was 6 yrs old and oldest patient was 75 yrs old.

Sex incidence: Acute appendicitis affects males more frequently than females. In our study there was a male preponderance for acute appendicitis with M: F ratio of 1.59:1. All patients in our series presented with pain abdomen, 64% of patients presented with pain in the right lower quadrant of abdomen and 36% of patients presented with pain in both umbilical and right lower quadrant region. Rebound tenderness at McBurney’s point was the commonest finding in the abdominal examination. It was found in 46% of patients in our study. 38% of patients had only right iliac fossa tenderness. Generalized guarding and rigidity was present in 12% of patients. In our study 70 cases were positive for acute appendicitis. Out of these 54 cases were uncomplicated acute appendicitis. Perforated acute appendicitis was diagnosed in 6 cases. 8 cases were diagnosed as appendicular abscess. In 4 cases complex appendicular mass was diagnosed. In our study 88 patients underwent appendicectomy accounting for 88 % of cases. In one case incision and drainage of collection was done.

Of the 100 cases, which were recruited for the study purpose on which the initial sonographic examination was done, 88 cases underwent appendectomy. Out of these 76 cases were proved to be acute appendicitis on histopathological examination, in the remaining 12 cases it was shown to be negative for acute appendicitis. Among the 100 cases for which ultrasound were done, 66 were shown to be positive for acute appendicitis, 10 cases were diagnosed as false-negatives and 10 cases were diagnosed as true-negatives. By ultrasound examination we were able to give alternative diagnoses in 12 cases, thus explaining the symptoms of patients.

Discussions

Our study was a prospective study of 100 patients clinically suspected for acute appendicitis. After a detailed history and clinical examination, the patients were subjected to ultrasound examination of the right iliac fossa using graded compression technique as explained by Puylaert using high resolution, high frequency probes (linear array 7.5-10MHz and curvilinear array 3.5-7.0MHz). Age prevalence showed that less than 5% of patients in the age group of 1-10 years and 6% of patients above the age group of 50 years were affected. Males were more commonly affected than females, with a male: female ratio of 1.58:1. These results were comparable to the study done by Lewis *et al* (1975) [8] who observed that less than 10% of patients were affected in the age group of 1-10 years and less than 10% of patients were affected in the age group of 50 years and above with male: female ratio of 2:1. In our study we could identify normal appendix in 8 cases of the total number of cases. The normal appendix was compressible, less than 6mm in diameter and ovoid in cross-section. In these cases we confidently excluded the diagnosis of acute appendicitis. This is in conformity with the study of Thomas rettenbacher *et al* (2003) [9]. In the remaining 10 cases ultrasound was unable to detect either normal or abnormal appendix. This was due to presence of guarding and rigidity, which hinders compression, non-visualisation of normal appendix per se, presence of localised ileus and obesity. In all cases of acute appendicitis, probe tenderness was present at the McBurney’s point. In 54 cases of the total number of cases where we could see an inflamed appendix, it was non-compressible and spherical in shape in all the cases. The outer diameter of the appendix was greater than 6mm in all the 54 cases. This finding is consistent with the criteria laid down by Jeffrey *et al* (1988) [10] and reinforced by the study of Thomas Rettenbacher *et al* (2001) [9]. In 46 cases out of 56 cases the outer diameter was 7mm or more. Appendicular abscess was visualized in 8 cases. Complex appendiceal mass was seen in 4 cases. The overall accuracy of sonography in the diagnosis of acute appendicitis in our study was 86.36%. In this study the observed sensitivity, specificity, predictive value of positive test and predictive value of negative test of ultrasound scanning with reference to histopathological confirmation was 86.64%, 83.33%, 97.05% and 50% respectively. Ultrasound not only diagnosed acute appendicitis but also diagnosed other conditions mimicking appendicitis. In our study, we could give an alternative diagnosis in 12 cases, where graded compression sonography was negative. In 10 cases the patients were managed conservatively based on our report. Thus we could prevent negative laparotomy in these cases. This is consistent with the studies of Gaensler *et al* (1989)

Table 1: Sex and age incidence

Age incidences	Males	Females	Total
1 – 10	-	2	4
11-20	14	10	24
21-30	32	12	44
31-40	6	6	12
41-50	8	4	12
51-60	-	4	4
61-70	-	-	-
71-80	2	-	2
Total	62	38	100

Table 2: Features of abdominal examination

Features	No. of cases
Tenderness	38
Rebound tenderness	46
Guarding & Ridgity	12

Table 3: abdominal ultrasonography

	No. of cases
Positive for appendicitis	72
Uncomplicated acute appendicitis	54
Perforated acute appendicitis	6
Appendicular abscess	8
Appendicular mass	4

[10, 11] and Emmie M Fa *et al* (1989) [12]. Hence we were able to either prevent a negative laparotomy or influence the surgical management.

Conclusion

Ultrasound being non-invasive, non-traumatic, readily available modality is a result-oriented examination in clinically equivocal cases of acute appendicitis.

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