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ULTRASONOGRAPHIC DIAGNOSIS AND GRADING OF ACUTE APPENDICITIS

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Purpose : *To evaluate the role of ultrasound in the diagnosis of acute appendicitis and present ultrasonographic grading for the disease*
Material and Methods : *This is a prospective controlled study of 232 patients with suspected acute appendicitis and 120 controls. All patients and controls underwent ultrasonographic examination, then divided into3 groups : group 1 (=100 patients) who proved surgically that they have acute appendicitis, group 2 (= 132 patients) who proved to have acute abdominal conditions other than appendicitis and group 3 (= 120 controls)*
Results : *In group I the inflamed appendix appeared as hypoechogenic shadow with thick fluid collection inside the lumen. The diameter of the wall of the inflamed appendix was 5 to 35 mm. A diameter more than 6 mm confirmed the diagnosis of acute appendicitis. The US findings seen in patients with acute appendicitis are presented and graded according to the severity. To our knowledge we are the first to present this ultrasonographic grading. In group II and III, the previous ultrasonographic findings were absent and the diameter of the wall of the appendix was between 2 and 4 mm.*
Conclusion : *ultrasonographic findings are useful in confirming the diagnosis of acute appendicitis and a normal ultrasoud exam is more useful in ruling out acute appendicitis. The ultrasonographic criteria can be graded and this grading might be helpful in assessing the severity of the disease .*

Key words : Ultrasound, Appendicitis, Diagnosis, Grading

INTRODUCTION

The role of US in the diagnosis of acute appendicitis have been established by several authors [1,2,3,4]. The outer diameter of the appendix has high sensitivity (= 100 %) but relatively low specificity (= 64 %) . The aim of this study was to assess the usefulness of ultrasonographic criteria in the diagnosis or ruling out acute appendicitis and to correlate these findings to the severity of the disease. To our knowledge, we are the first to report such grading and correlation.

PATIENTS AND METHODS

The study was conducted between January 2001 and July 2002. Patients were referred from differents clinics into the radiology departments in the Military hospital, the Yemeni – German hospital and the Yemen Specialized Hospital. 232 patients with suspected appendicitis and 120 controls included in the study, ages ranged between 5 and 60 years, 108 were women and 224 were men. All controls were healthy males who attended the Military hospital for medical check-up.

The relevant history was taken and all patients underwent clinical and ultrasound examination .Complete blood picture and urine testing were carried out on all participants. All patients underwent surgical or medical management and all participants divided into 3 groups (Table 1): group 1 (=100 patients) who proved surgically that they have acute appendicitis, group 2 (= 132 patients) who proved to have acute abdominal conditions other than appendicitis and group 3 (= 120 controls)

The ultrasound technique : All US examinations

conducted in this study were performed by the main investigator and assistant radiologist in the presence of the surgeon or gastroenterologist in duty. The equipments used in the examination were Sonoline versa and Sonoline versa plus which had multiple probes including 5 to 7.5 MHz linear-array and 3.5 to 5 MHz convex-array. 3.5 MHz probe was used for general examination of the whole abdomen in adults and 5 MHz probe in children.

We started the examination with 3.5 MHz probe for the main abdominal organs (liver, spleen, kidneys, pancreas, Retropretonium and pelvic organs) then the examination was completed with superficial probes 5 to 7.5 MHz concentrating on the right iliac Fossa. Time of the examination for each patient was between 10 to 15 minutes. The inflamed appendix appeared as well circumscribed hypoechoic ring with double wall in the transvers plane and tubular structure with blind end in the longitudinal plane. We measured the mean diameter of the wall

RESULTS

In group I : The US findings were classified into 3 grades according to the severity of acute appendicitis : Grade 1 characterized by thickening of the wall of the appendix between 4 to 6 mm with no other US findings and this type was seen in 52 patients(=52%), in the first 24 hrs of the first attack of acute abdominal pain and correlated with an early acute appendicitis. Grade II characterized by thickening of the wall of the appendix more than 6 mm with thick inhomogenous content and sometimes calcification inside the lumen. Other US findings might be seen in this grade : mild free fluid collection in the surrounding area, mild thickening of the wall of the terminal ileum and caecum and low peristalysis in the right iliac fossa. These US findings were seen in 34 patients (34 %) after 24 hrs and this grade was correlated with severe types, associated with signs of localized peritonitis and perforated or gangrenous appendix.

Grade III characterized by the presence of an abscess or a mass with generalized thickening of the intestinal wall. mesoappendix and rarely the surrounding soft tissues in the right iliac fossa. This findings were seen in 14 patients (= 14 %) after 36 hrs from the onset of acute abdominal pain and they are correlated with an abscess or mass formation. The wall of the vermiform appendix was not seen in this grade.

The ultrasonographic criteria and grades of appendicitis are shown in (Table 2) and (Figs 1,2,3)

In group II : US was very useful in diagnosing the causes of acute abdomen other than acute appendicitis : right ureteric stones (= 46 patients), rupture or twisted ovarian cyst (= 7 patients) intussusception(= 3 patients), ectopic pregnancy (= 2 patients).

In group III: (controls), the ultrasonographic findings were normal except in 4 participants : two had renal stones and in the other two the appendicular wall was thickened between 4 and 5 mm, without previous history of acute appendicitis The causes of acute abdominal pain in 232 patients are summarized in (Table 3).

Statistical analysis : for the data displayed in (Table 2), the log linear analysis was utilized. This approach is commonly used for analyzing multidimensional contingency table. Using the log linear analysis approach, the analysis results are shown in (Table 4) . The null hypotheses to be tested are such that :

- There is no relationship between ultrasonographic grading in patients and group types.
- There is no interaction relationship between ultrasonographic grading in patients and group types.

Based on the results in (Table 4), the above hypotheses are clearly rejected, as there are strong relationships between group types and ultrasonographic grading in patients. Moreover, the group types are significantly interacting with ultrasonographic grading in patients. These conclusions are easily drawn from (Table 4) . The analysis of results for the data in (Table 3) are displayed in (Table 5) The results in (Table 5) showed that both the group and sex variables are associated with highly significant probability values.

Table (1) : ***The study groups***

G1	100	Appendicitis	28.4 %
G2	132	Acute non-appendicular pain	37.5 %
G3	120	Normal volunteers (controls)	34 %

Table (2) : ***Ultrasonographic grading in 100 patients(GROUP ONE) with Acut Appendicitis .***

Patients No	*grade*	*Wall thickness of appendix*	*Free fluid in the R.I.F and pelvis*	*Thickening of the surround intestinal lobes*	*Mass of abscess formation*
52	Grade 1	Positive 4 – 6 mm	Negative	Negative	Negative
34	Grade 2	> 6 mm	Positive	Positive	Negative
14	Grade 3	Not seen	Positive or Negative	Positive	Positive

Table (3) : ***232 patients with acute abdominal pain and clinically suspected appendicitis***

Diagnosis	*No.*	*%*
Acute Appendicitis	100	43 %
Rt. Uerteric, renal stone	46	19.8 %
Acute Enteritis	12	5.1 %
Rupture of Overian cyst or torsion	7	3 %
Mesenteric TB	6	2.5 %
Acute colitis	5	2.1 %
Salpangitis + Other C.P.I.D	4	1.7 %
Intussusceptions	3	1.2 %
Ectopic Pregnancy	2	0.86 %
Mesenteric lymphadenitis	2	0.86 %
Carcinoid Tumor	1	0.43 %
Non-specific acute abdominal pain	44	18.9 %

Table (4) : ***Ultrasonographic grading in patients***

Effect Name	*Chi-square*	*P-value*
Group Type * Grading in Patients	602.001	0.000
Group Type	93.216	0.000
Grading in patients	308.969	0.000

Table (5):

Variable	*F-test*	*P-value*
Group	28243.88	0.000
Sex	100.08	0.000

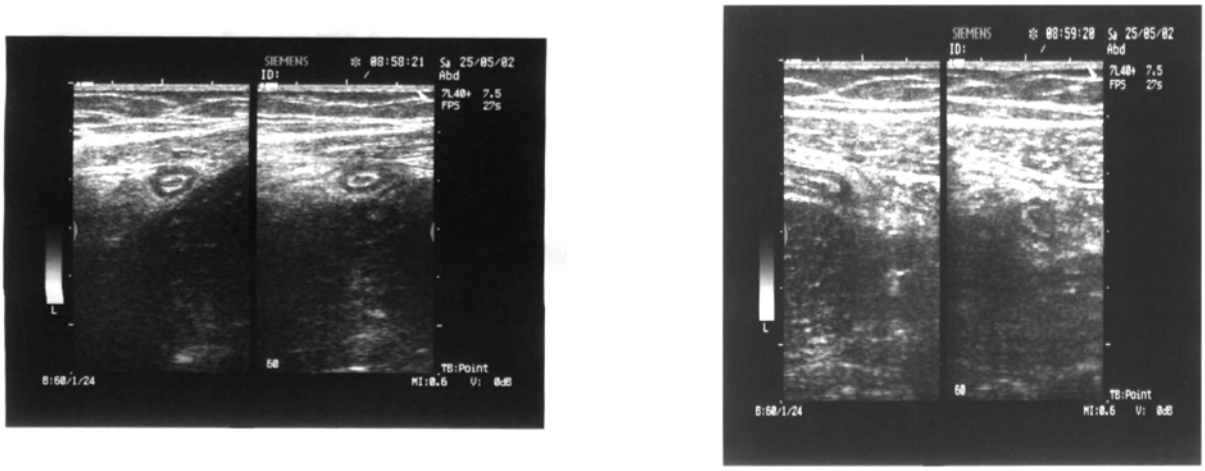

Fig. (1)

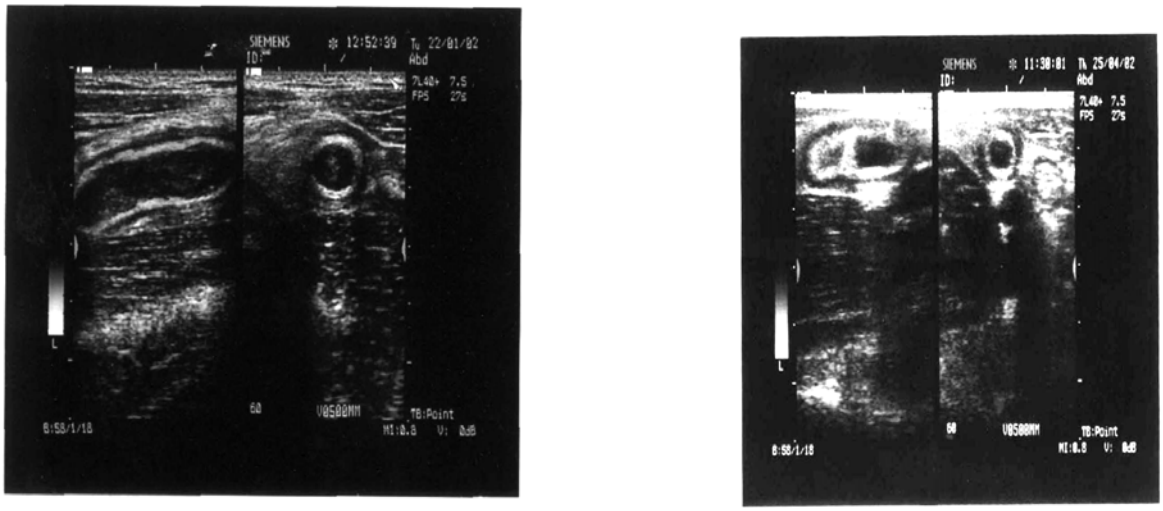

Fig. (2)

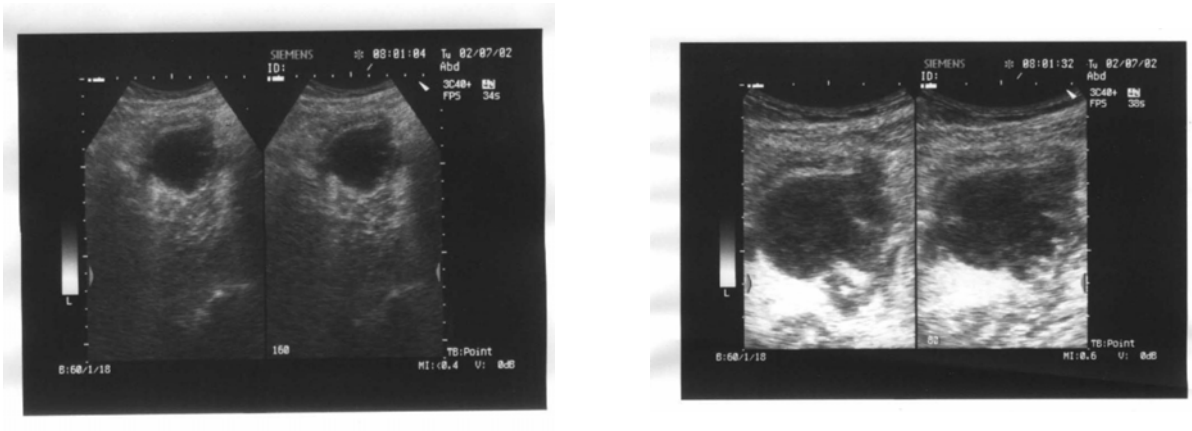

Fig. (3)

DISCUSSION

Several cross sectional imaging studies demonstrated that outer diameters of acutely inflamed appendices are not less than 6 mm [1,2,10–12] or 7 mm [4, 6, 7, 9], while others reported diameters of 5 mm [5], and 4 mm [8,13]. In the present study a diameter of the appendicular wall more than 6 mm confirmed the diagnosis of acute appendicitis. Several authors reported a marked overlap of diameters of normal and acutely inflamed appendices measured by US in children [15] This increase in the diameter of normal appendices might be caused by lymphatic hyperplasia which is commonly seen in children. In children we had similar difficultiess in assessing the diameter in2 girls with acute appendicitis were the diameter was 4 mm and one of these girls had ruptured appendix after 24haurs. Therefore, in children, It advisable to repeat US examination if the wall thickness is less than 5 mm and to depend on several US criteria simultaneously.

In our experience the abdominal us imaging was useful in confirming the diagnosis of acute appendicitis and more importantly in excluding acute appendicitis. Of course the type of the machine and the experience of the ultrasonographer play an important role in the accuracy of the diagnosis.

One of the several advantages of US imaging in acute appendicitis that it might diagnose other simulating conditions of acute abdomen such as ruptured ectopic pregnancy, Right ureteric stone,and their complications. The grading of acute appendicitis by US imaging into 3 groups might help the surgeon in making the right decesion for example to operate in case of perforated appendix or to treat conservatively in an appendicular mass.One of the difficulties was in the differential diagnosis between grade 2 appendicitis and earlyruptured ectopic prignancy and localised pritonitis in the right iliac fossadue to other causes,when the vermiform appendix not seen.

CONCLUSION

The results of this study showed that U.S. imaging of the abdomen can be useful in confirming the diagnosis of acute appendicitis and US imaging was more useful in excluding acute appendicitis and diagnosing other causes of acute abdomen. Ultrasonographic grading according to the severity of the disease might help surgeons to take the correct decision in the management of acute appendicitis. Further studies are needed to evaluate the role of U.S. in the diagnosis of acute appendicitis.

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