

# THE VALUE OF ULTRASOUND IN THE DIAGNOSIS OF ACUTE APPENDICITIS AND MIMICKING CONDITIONS

*By*

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## **ABSTRACT**

*Purpose :* To evaluate the role of ultrasound in the diagnosis of acute appendicitis, especially, atypical cases and mimicking conditions.

*Patient and Methods :* This is a prospective controlled study of 858 patients with suspected acute appendicitis and 240 controls. All patients and controls underwent ultrasonographic examination, then divided into 3 groups : group I (284 patients) who were proved sonographically and surgically that they have acute appendicitis, group II (574 patients) who proved to have acute abdominal conditions other than appendicitis including cases with false negative and

false positive results by US, and group III (240 controls).

*Results :* In group I the inflamed appendix appeared as hypoechogenic shadow with thick fluid collection inside the lumen. The diameter of the wall and lumen of the inflamed appendix was ranging between 4 to 35 mm. Early cases were characterized sonographically by thickening of the wall of the appendix between, 4 to 6 mm, non-compressible aperistaltic appendix, in homogeneous content and sometimes faecolith or gas inside the lumen. late cases were characterized by thickening of the appendicular wall > 6 mm, free liquid collections, and this was associated with

perforated or gangrenous appendix. In group II, Ultrasonography was very useful in excluding acute appendicitis and diagnosing the causes of acute abdomen other than acute appendicitis.

*Conclusion* : ultrasonographic findings are useful in confirming the diagnosis of acute appendicitis and a normal ultrasound exam was more useful in ruling out acute appendicitis. US imaging was more useful in excluding acute appendicitis and diagnosing other causes of acute abdomen.

*Key Words* : Ultrasound, Appendicitis, Diagnosis.

## INTRODUCTION

Acute abdominal pain continues to present a difficult diagnostic challenge in patient care. Appendicitis as a cause of abdominal pain is relatively common with each person having a 6% chance of developing this entity during his or her lifetime. As established by several authors (1,2,3,4), the maximal outer diameter of the normal appendix can measure up to 6 mm (5). The ultrasound features of acute

appendicitis are: a distended, non-compressible, thick-walled appendix in which an obstructing faecolith may be visible. The surrounding fat is inflamed and echogenic and moves with the appendix on compression. Free fluid may be present. The outer diameter of the appendix has high sensitivity (100 %) but relatively low specificity (64 %). The ultrasound pattern of acute appendicitis is characterized by "target" like appearance of the appendix (bull's eye) in transverse scan (5). The typical target lesion consists of a hypoechoic, fluid distended lumen, a hyperechoic inner ring representing mainly the mucosa and submucosa, and an outer hypoechoic ring representing the muscularis externa. The inflamed appendix is further characterized by lack of peristalsis and compressibility, and demonstration of its blind end tip (5).

Appendicitis occurs in men 1.4 times more frequently than in women. It gradually rises in incidence from birth through early childhood, peaks in the late teens to early twenties, and then gradually declines through the geriatric years. The incidence is lower in cultures with higher intake of die-

tary fiber. This is thought to be secondary to increased transit times through the bowel, which encourages the formation of a fecalith. There is some familial predisposition.

Typical appendicitis are easy to diagnose, but it can sometimes be very difficult to make a diagnosis in atypical cases. The exact incidence of appendicitis and appendectomy is not known in Yemen. However, appendectomy is the most common emergency operation in Yemen. The aim of this study was to assess the value of sonography in the diagnosis of suspected appendicitis and the differential diagnosis of acute lower abdominal quadrant pain.

## PATIENT AND METHODS

The study was conducted between January 2005 and October 2007. Patients were referred from different clinics into the radiology departments in the Yemen Military hospital and the Yemen - German hospital in Sana'a. 858 patients with acute abdomen (suspected appendicitis) and 240 controls were included in the study with ages ranged between 5 and 60 years. All controls were healthy males

who attended 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 were divided into 3 groups (table 1): group I (284 patients) who proved surgically to have acute appendicitis, group II (574 patients) who proved to have acute abdominal conditions other than appendicitis and group III (240 controls).

*The ultrasound technique* (color doppler US machines) 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 US machine had multiple probes including 5 to 13 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 5MHz probe in children. The examination started with 3.5 MHz probe for screening the main abdominal organs (liver, spleen, kidneys, pancreas, retroperitoneum

and pelvic organs) then the examination was completed with superficial probe 5-13 MHz concentrating on the right iliac Fossa. Time of examination for each patient was between 10 to 15 minutes.

## RESULTS

**Group I (284 patient):** In this group there were slight male to female predominance with a ratio of 1.3: 1 (163 males and 121 females). Early cases (198 cases) were characterized sonographically by thickening of the wall of the appendix between, 4 to 6 mm, non-compressible aperistaltic appendix, inhomogeneous content and sometimes faecolith or gas inside the lumen.

The ultrasonographic findings in late cases (86 cases) were thickening of the appendicular wall > 6 mm, free liquid collections, and this was associated with perforated or gangrenous appendix. The sonographic findings in appendicitis are shown in Figures 1,2 ,3. Also late cases were characterized by the presence of an abscess or a mass with generalized thickening of the intestinal wall, mesoappendix and rarely soft tissue in

the right iliac fossa. These findings were seen after 36 hours from the onset of acute abdominal pain. In group II (574 patients), Ultrasonography was very useful in excluding acute appendicitis and diagnosing the causes of acute abdomen other than acute appendicitis.

**Group II (574 patients):** The commonest causes of acute non-appendicular pain were non-specific acute abdominal pain in 162 patients (18.8% among non appendicular cases), right Ureteric stone 152 patients (71.7%) (high incidence among yemeni patients), acute gynecological pathology 86 patients (9.9%) and acute enteritis 44 patients (5.2%). The causes of acute abdominal pain are summerized in table 3.

False negative results more present in 29 patients (3.82%) with surgical and pathologic proof of acute appendicitis due to abnormal retrocecal location, atypical site or narrow small diameter.

False-positive results more present in 5 patients proved surgically to have conditions other than appen-

ditis. This gives sensitivity of 90% and a specificity of 98% in the detection of appendicitis.

Group III (control), the ultrasonographic findings were normal except 4 participants; two had renal stones and in the other two the appendicular wall was between 4 and 5 mm, without previous history of acute appendicitis.

### STATISTICAL ANALYSIS

Table 2 displays the analysis results of three groups of cases considered for evaluating the rule of ultrasound in the diagnosis of acute appendicitis. A prospective controlled study of 858 patients with suspected acute appendicitis is statistically compared to a control group of 244 cases. Based on the Ultrasonographic examination, all patients as well as the controls were then classified into three groups, and of 284, 574 and 240 patients, respectively. The patients in were sonographically and surgically found to have acute appendicitis, those patients in were proven to have acute abdominal conditions

other than appendicitis and those in were considered as the controls.

The usual statistical hypothesis is to test for any significant differences between experimental and control groups. Table 1, summarizes the statistical analysis of these three groups. The multiple pairwise comparisons test results clearly indicated that the experimental groups are significantly different when compared to the controls. This can be concluded from the large values of the Chi-Square test statistics and the corresponding probability values ( $P < 0.05$ ).

Table 3 shows that the significance tests to diagnosis levels of 858 patients with acute abdominal pains and clinically suspected appendicitis. All the levels were found to be significant ( $P < 0.05$ ). The analysis of total variations (pooled diagnosis levels) was found to be highly significant ( $P < 0.05$ ). Moreover, these diagnosed cases were also analyzed using multiple pairwise comparisons and all pairwise tests yielded significant results ( $P < 0.05$ ).

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

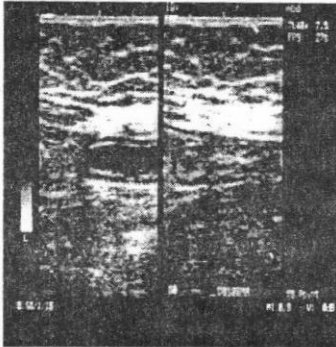
|      |                                | No.  | %    |
|------|--------------------------------|------|------|
| GI   | Appendicitis                   | 284  | 25.9 |
| GII  | Acute non-appendicular pain    | 574  | 52.2 |
| GIII | Normal volunteers ( controls ) | 240  | 21.9 |
|      | Total                          | 1098 | 100  |

**Table 2: significance tests of groups differences**

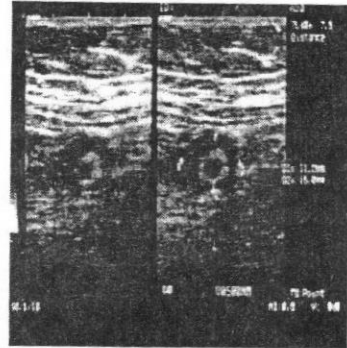
| Multiple pairwise comparisons tests | Exact tests |         |
|-------------------------------------|-------------|---------|
|                                     | Chi-square  | P-value |
| $G_I$ vs $G_{III}$                  | 699.24      | 0.000   |
| $G_{II}$ vs $G_{III}$               | 793.70      | 0.000   |
| $G_I$ vs $G_{II}$                   | 838.55      | 0.000   |
| All patients vs $G_{III}$           | 1074.58     | 0.000   |

**Table 3: 858 patients with acute abdominal pain and clinically suspected appendicitis**

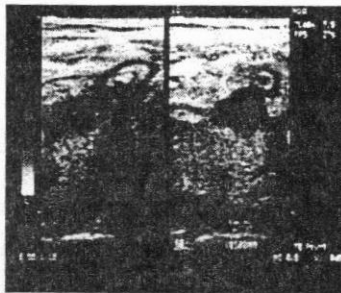
| Level | Diagnosis                          | No. of pts. | %    | Goodness of fit |
|-------|------------------------------------|-------------|------|-----------------|
|       |                                    |             |      | P-values        |
| 1     | Acute Appendicitis                 | 284         | 33.1 | 0.001           |
| 2     | Rt. Uerteric, renal stone          | 152         | 17.7 | 0.001           |
| 3     | Acute Enteritis                    | 44          | 5.2  | 0.001           |
| 4     | Rupture of ovarian cyst or torsion | 42          | 4.8  | 0.001           |
| 5     | Mesenteric TB                      | 32          | 3.7  | 0.001           |
| 6     | Acute colitis                      | 27          | 3.3  | 0.001           |
| 7     | Salpangitis + Other C.P.I.D        | 26          | 3    | 0.001           |
| 8     | Intussusceptions                   | 19          | 2.2  | 0.001           |
| 9     | Ecotopic Pregnancy                 | 18          | 2.1  | 0.05            |
| 10    | Mesenteric lymphadenitis           | 15          | 1.8  | 0.05            |
| 11    | Characinoid Tumor and lymphoma     | 8           | 0.9  | 0.001           |
| 12    | False negative appendicitis        | 29          | 3.4  | 0.001           |
| 13    | Non-specific acute abdominal pain  | 162         | 18.8 | 0.001           |
| Total |                                    | 858         | 100  | 0.000           |



**Figure 1 :** Early acute appendicitis in axial and longitudinal view



**Figure 2 :** Thick edematous appendix wall with target sign in transvers slice



**Figure 3 :** Perforated appendicitis (Appendicular abscess). An obstructing intraluminal foreign body is noticed.



## DISCUSSION

The present results demonstrated that ultrasonography had a high diagnostic accuracy not only for acute appendicitis but also for other conditions such as right ureteric stones, ectopic pregnancy or intussusceptions. The overall accuracy was (92 %), sensitivity was (90%) and specificity was (98%) of the US examination in this study matched that with other prospective studies. The normal appendix is hardly visualized by sonography. The visualization rate vary widely in the published literature, from a low 2% to a high percent of 82% (6,7,8,9). In our study we examined 240 healthy adults and found the appendix in only 2 patients with appendicular wall between 4 and 5 mm without previous history of acute lower quadrant abdominal pain.

In the present study a diameter of the appendicular wall more than 6 mm confirmed the diagnosis of acute appendicitis. In one study done by Horrow and others evaluated the role of US and CT in suspected appendicitis in children, it was found that US and CT were accurate modalities in the diagnosis of acute appendicitis in

children. US was most useful in patients with equivocal clinical findings. US should be the first modality used to evaluate children with suspected appendicitis. CT should be reserved for cases where US is sub-optimal or where the findings are inconsistent with the clinical findings<sup>(9)</sup>.

In the present study the abdominal US imaging was useful in confirming the diagnosis of acute appendicitis and more importantly in excluding acute appendicitis especially, when the diameter of appendicular wall is less than 6mm with a probability of >90%, high specificity. This study had a false-negative US results in 29 patients, which might be explained by superimposed air, obesity, abdominal rigidity, and uncooperative patient. Similar experiences have been reported by several authors (10,11,12,13,15).

To minimize the error of US measuring the appendicular diameter, some authors recommended to depict the appendix in longitudinal and transverse planes<sup>(14,16)</sup>. The type of the machine and the experience of the ultrasonographer play an impor-



tant role in the accuracy of the diagnosis. One of the several advantages of US imaging in acute appendicitis is that it might diagnose other simulating conditions of acute abdomen such as ruptured ectopic pregnancy, right ureteric stone, and their complications.

*In conclusion :* The results of this study showed that US imaging of the abdomen could be useful in confirming the diagnosis of acute appendicitis especially in atypical cases or in difficult groups such as children, elderly and obese. In this study, US imaging was more useful in excluding acute appendicitis and diagnosing other causes of acute abdomen. Ultrasound should not be used by those who are inexperienced in the clinical diagnosis of appendicitis.

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