

# Indication and usefulness of ultrasonography for suspected acute appendicitis at the emergency department

REBECA PINTADO GARRIDO<sup>1</sup>, MARTA MOYA DE LA CALLE<sup>2</sup>, SUSANA SÁNCHEZ RAMÓN<sup>2</sup>, MIGUEL ÁNGEL CASTRO VILLAMOR<sup>2</sup>, SARA PLAZA LOMA<sup>1</sup>, MARCELINO MENDO GONZÁLEZ<sup>1</sup>

<sup>1</sup>Radiodiagnosis Department. <sup>2</sup>Emergency Department. Río Hortera University Hospital. Valladolid, Spain.

## CORRESPONDENCE:

Susana Sánchez Ramón  
C/ Ciudad de la Habana 19, 2ªA  
47016 Valladolid  
E-mail: sussanchez@ono.com

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## CONFLICT OF INTEREST:

None

**Background:** Appendicitis is the most common cause of acute abdominal pain and subsequent surgery. For that reason the diagnosis of this condition is a cause of big concern in emergency departments.

**Objective:** The aim of the present study was to assess the usefulness of ultrasonography in the diagnosis of acute appendicitis.

**Methods:** Retrospective study which included patients presented in the emergency department with abdominal pain of suspected acute abdominal disorder origin and remitted to undergone ultrasonography to rule out appendicitis from January to July 2004.

**Results:** Among 2015 ultrasonography scans 296 were performed to exclude a diagnosis of acute appendicitis. 288 could be interpreted and the diagnosis of acute appendicitis was established in 52. In 15 cases the ultrasonography and the definite diagnosis differed. Ultrasonography and surgical diagnosis were different in 6 patients. In 9 patients the ultrasonography was not diagnostic. Ultrasound sensitivity, specificity, positive predictive value, and negative predictive value were 83.7%, 97.4%, 87.7% and 96.2%, respectively.

**Conclusions:** The global cost-effectiveness of ultrasonography to diagnose appendicitis is good. Due to its availability and its low cost, ultrasonography is an accurate test for the diagnosis of acute appendicitis in emergency departments, specially in uncertain cases. [Emergencias 2008;20:81-86]

**Key words:** Acute appendicitis. Acute abdominal disorder. Ultrasonography.

## Introduction

Acute appendicitis (AA) is the most commonly occurring abdominal acute condition in emergency departments<sup>1,2</sup>.

It can present at all ages, although it occurs more frequently during the 2<sup>nd</sup> and 3<sup>rd</sup> decades of life. Although it is relatively rare among extreme age-groups, it is more complicated when it does occur, due to difficulty in pinpointing exact pain location and in giving an accurate description of symptoms.

The overall lifetime risk of developing appendicitis is estimated to be of 7%. Around 1% of outpatients presenting with abdominal pain have acute appendicitis (2.3% in the case of children)<sup>3,4</sup>. The mortality rate in non-complicated cases is of 0.3%, increasing to 1-3% in ca-

ses of perforation and to 5-15% among the elderly.

It is traditionally believed that acute appendicitis is caused by an infection due to an obstructive problem. The main cause for obstruction in 60% of cases is hyperplasia of submucosal lymphoid follicles. In 30-40% of cases, it is due to a faecalith or appendicolith (rarely visible via x-ray), with the remaining 4% being attributed to foreign bodies. In exceptional cases (1%), it is the form of presentation of appendicular tumours.

Typical symptoms include pain initially centred in the epigastric region and subsequently moving to the right iliac fossa (RIF), presenting along with fever, nausea and vomiting, although this only occurs in 70% of cases<sup>5</sup>.

Until recently, surgical treatment was recommended for any case of RIF pain with a reasona-

ble suspicion of AA, which led to a very high rate of unnecessary appendectomies (10-30%)<sup>6</sup>.

The main clinical problems currently posed by appendicitis are its significant rate of post-surgical morbidity (18%)<sup>7</sup> and that diagnostic and therapeutic delay can lead to the onset of a histologically more severe appendicitis as a result of an increased risk of perforation<sup>6,8,9</sup>.

The highly accurate diagnostic imaging methods currently available help to improve the management of patients with suspected AA<sup>10</sup>. Both ultrasound and CT scans have proven to be highly reliable methods for diagnosing appendicitis<sup>11</sup>, but the indications and circumstances dictating which method should be used remain subject to discussion<sup>3</sup>. The initial diagnostic imaging test in most centres is ultrasonography<sup>6,12</sup>. This study assesses the need for ultrasonography in the diagnosis of AA in an emergency department.

## Method

This is a descriptive, observational and retrospective study, involving the review of clinical histories of patients attended in the emergency department of our hospital from January to June 2004. A total of 2015 emergency abdominal ultrasounds were performed during this period, 296 being requested for suspected AA.

Initial clinical assessments and ultrasound requests were made in all cases by an emergency department physician.

The following data were collected: epidemiological (sex and age), clinical (pain in lower right hemi-abdomen, fever, physical exploration and analyses), ultrasonographic and histopathological.

The diagnosis of clinically suspected appendicitis was made on the basis of pain in the lower right hemi-abdomen and the presence or absence of one or more of the following criteria: fever (deemed to be a body temperature at physical exploration above 37.5°C), leukocytosis (>10.000 U/ml) and Blumberg's sign (pain following abdominal decompression).

The final diagnosis was made comparing the ultrasonographic findings with the histopathological study results, except for cases of appendiceal adhesion masses for which post-surgical findings were taken into consideration. A clinical radiological follow-up was performed in non-surgical patients.

The ultrasonographic exploration of the right iliac fossa is performed by gradual compression: continuous, uniform pressure is applied to the ex-

ploration area to displace the air from the intestinal ansae and to minimise pain caused to the patient, avoiding rebound pain due to successive compression and decompression. High resolution transducers, and occasionally Doppler-colour, are used.

The ultrasonographic criteria used by the Radiology Department to diagnose acute appendicitis were: identification of a tubular intestinal structure located in the lower right hemi-abdomen, closed at one end, with a transverse diameter exceeding 6 mm, not compressible and aperistaltic, the appearance of appendicolith and/or the presence of extra-appendicular alterations such as inflamed peri-enteric fat, phlegmon or peri-appendicular abscess.

Variables were compiled in Excel tables and analysed and processed via the Windows SPSS programme version 11.0. Discrete variables were described using absolute frequencies (percentages) and continuous variables as means and standard deviations. The  $\chi^2$  test (or Fisher exact test in calculated values under 5) for discrete variables and the Student t test for continuous variables were applied when required. Statistical significance was set at  $p < 0.05$ . Diagnostic performance markers were sensitivity, specificity, positive predictive value and diagnostic efficacy.

## Results

Pain in RIF with clinical suspicion of acute appendicitis accounted for 15% of the emergency ultrasound explorations.

Of the 296 emergency ultrasounds requested due to suspected appendicitis, this diagnosis could not be evaluated in 8 cases: 7 due to the presence of abundant abdominal gas preventing adequate observation of intestinal ansae and in one case due to obesity. As for the 288 remaining cases, the age ranged between 2 to 92 years (mean 31.4 years) and 162 were women (56%) and 126 men (44%).

Table 1 shows the various end diagnoses arrived at for the patients following clinical assessment and ultrasound performance. The diagnosis of non-specific abdominal pain was the most frequent of the pathologies found, accounting for 67% thereof.

The diagnostic value obtained by the ultrasound is shown in Figure 1. The following results on ultrasound performance in the diagnosis of appendicitis at our hospital were obtained: 83.7% sensitivity, 97.4% specificity, 87.7% positive pre-

dictive value, 96.2% negative predictive value and 95% diagnostic efficacy (Figure 2).

The ultrasonographic findings in patients undergoing diagnostic ultrasonography were: identification of a tubular structure exceeding 6 mm in diameter (97.7%), abdominal free fluid (42.8%), inflamed echogenic surrounding mesoappendix (39.5%), presence of appendicolith (25.6%) and appendiceal adhesions or abscess (6.9%).

In all cases in which the ultrasound was performed for suspicion of acute appendicitis which was subsequently not confirmed, the observations included a tubular structure over 6 mm, inflamed surrounding mesoappendix in 66.7%, free fluid in 33.3% and appendicolith in 16.7% of cases. The final diagnosis in these cases was: non-specific abdominal pain in 3 cases, pelvic inflammatory disease in 1 case, acute gastroenteritis in 1 case and cecal diverticulitis in the last case.

Of the 9 false negative cases, 7 showed a totally normal ultrasonographic exploration, free fluid was observed in the pelvis in one case and in the last case the ultrasound was performed for suspected terminal ileitis. Of the true negatives 83% were finally diagnosed as non-specific abdominal pain.

## Discussion

Despite being one of the most frequent diagnoses among surgical emergencies, AA continues to pose significant diagnostic problems.

The diagnosis of AA in most cases is based on clinical history and physical exploration<sup>13</sup>.

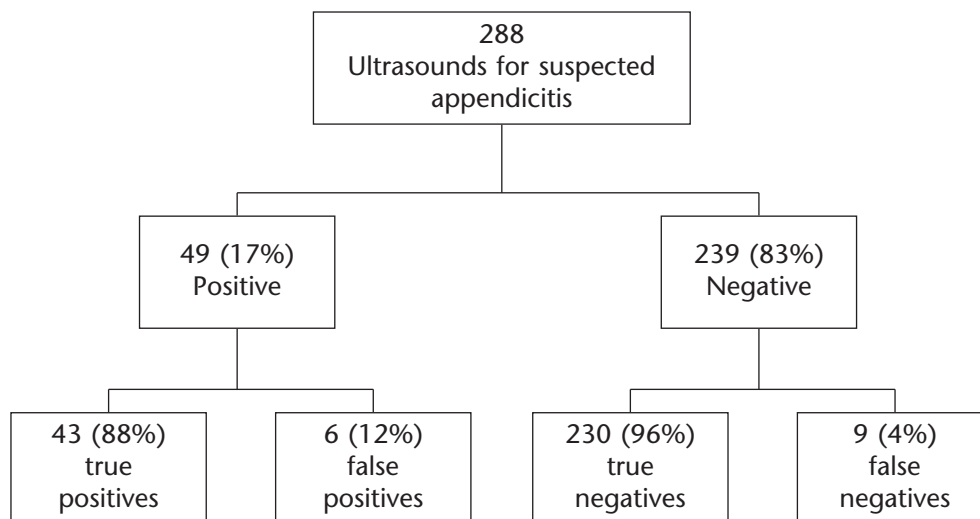
**Table 1.** Final clinical diagnoses following ultrasound performance in the 288 patients included in the study

Diagnosis	Number of patients	Percentage
Non-specific abdominal pain	194	67.4
Appendicitis	52	18
Gastrointestinal disorders	24	8.4
Gynaecological disorders	9	3.1
Other	9	3.1

At our hospital emergency department, in cases with a medical history and physical exploration suggestive of possible appendicitis, chest and abdominal radiography and blood analyses are routinely performed. Of all signs and symptoms, only the presence of leukocytosis and a positive Blumberg's sign show a statistically significant association with the diagnosis of AA.

Thirty percent of clinical cases are atypical and confusing<sup>5</sup>, leading to diagnostic errors and an increase in the number of unnecessary laparotomies. This situation may prove particularly problematic for women who may present with acute gynaecological symptoms which could, to a large extent, simulate those of acute appendicitis. It is in these atypical cases where many studies<sup>6,14,15</sup> show that ultrasonography is useful in arriving at a diagnosis of appendicitis, whilst proving less useful in patients with a high clinical probability of appendicitis who require immediate surgical assessment and for whom any delay in treatment should be avoided to reduce potential complications.

Image testing on suspicion of AA should be used as a diagnostic complement in selected cases and not as a routine tool in the initial clinical exploration.



**Figure 1.** Results of ultrasounds performed.

		Clinical histological end diagnosis		
		Appendicitis	Non-appendicitis	Total
Ultrasound diagnosis	Appendicitis	43	6	49
	Non-Appendicitis	9	230	239
Total		52	236	288

Sensitivity:	$43 / 52 = 0.83$
Specificity:	$230 / 236 = 0.97$
Positive predictive value:	$43 / 49 = 0.88$
Negative predictive value:	$230 / 239 = 0.96$
Diagnostic accuracy:	$(43 + 230) / 288 = 0.95$

**Figure 2.** Calculation of sensitivity, specificity, positive and negative predictive values and diagnostic accuracy.

The only specific sign of AA that can be observed via a simple abdominal radiography is the presence of appendicolith (provided there are other compatible symptoms). Other signs yielded by abdominal radiography, such as the presence of a dilated ansa, hydroaerial levels, antalgic scoliosis and erased psoas, are less specific<sup>9</sup>.

Another complementary method is abdominal ultrasonography, which in our case is usually the final diagnostic test. Among our patients we have confirmed the usefulness of ultrasonography as a diagnostic confirmation test (high positive predictive value, negative predictive value and specificity). Observation of an enlarged and non-compressible appendix is a sign of high positive predictive value. Nevertheless, the main difficulty posed by appendicitis ultrasound lies in eliminating the presence thereof. The usual negative diagnostic criterion (lack of visual appreciation of an inflamed appendix) may be due to the non-existence of appendicitis or to the impossibility of confirmation thereof which has often led to negative predictive ultrasound values to be lower than the positive values<sup>7</sup>. The literature reports a rate of perforated acute appendicitis of 21%<sup>16</sup>, but the existence of false negatives rises to 44% due to the reduction in sensitivity caused by the perforation, that is, the identification of a non-compressible tubular structure of a +6 mm. diameter – the ultrasonographic sign most indicative of appendicitis<sup>2</sup> – is no longer visible as it becomes concealed within the adhesion mass that is formed by the perforation. Another cause of ultrasound false negatives is the precocity in many cases when performing the test<sup>17</sup>. It is therefore very important to interpret the ultrasonography in each individual clinical context, particularly in cases in the early stages.

A great number of studies<sup>6,14,17,18</sup> recommend that if clinical findings still suggest appendicitis despite negative ultrasound results, the patient should remain under hospital observation and subject to clinical exploration and, in some cases, successive ultrasonographies and even surgery.

It must not be forgotten that the ultrasonographic results of the physician performing the test since the results may vary between those of an inexperienced physician and those of one familiar with the test, often explaining the false negatives and positives reported, and the lower number of false results obtained by more experienced ultrasound physicians<sup>12,17,19</sup>.

The diagnostic values obtained in this study are similar to those published to date<sup>1,11</sup>.

Another complementary imaging test that can be performed for an emergency diagnosis of AA is Computed Tomography (CT). The higher sensitivity provided by CT makes it more useful according to various studies<sup>9,13,14</sup> when diagnosing AA. Moreover, CT is less painful and offers a better performance in the diagnosis of other abdominal diseases, thus leading to many more alternative diagnoses<sup>9,13</sup>. Its main disadvantages are a higher radiation level, higher cost and the need, according to some authors, to use contrast material<sup>9</sup>.

We believe that the use of CT is advisable in cases of inconclusive results from analyses, routine radiographies and ultrasonographies performed, as well as in the case of an evolutive or complex disease, as it enables a more reliable detection of the presence of appendicular adhesions or abscess, and particularly in the elderly, for whom the risk of radiation exposure is minimal. In most of the cases in our series, the ultrasound proved sufficient to achieve a diagnosis as has been shown in the results, moreover offering the possibility of making alternative diagnoses<sup>20</sup>.

We believe that the false positives obtained are related to the inexperience of the ultrasonographer performing the test plus the fact that many appendicitis cases do not undergo surgical intervention but rather are treated with antibiotics. We consider that the false negatives obtained are related to appendicular perforation, as in such cases the sensitivity is reduced due to the enlarged tubular structure being less visible. This hypothesis, however, has not been tested in our study.

We thus conclude that abdominal ultrasonography is the most useful complementary exploration in emergency departments for diagnosing acute appendicitis (95% accuracy) especially in cases of doubtful diagnosis. The accessibility and low cost of this approach make it ideal for emer-

gency diagnosis, offering high levels of sensitivity and specificity. Its contribution often renders it essential in the study of acute appendicitis, as it helps achieve a large number of alternative diagnoses thereby assisting physicians in decision making in doubtful cases and reducing the rate of unnecessary laparotomies.

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## Indicación y utilidad de la ecografía urgente en la sospecha de apendicitis aguda

**Pintado Garrido R, Moya de la Calle M, Sánchez Ramón S, Castro Villamor MA, Plaza Loma S, Mendo González M**

**Objetivo:** La apendicitis aguda es la patología quirúrgica aguda abdominal más frecuente. Su diagnóstico constituye uno de los problemas más habituales en los servicios de urgencias. El objetivo del presente estudio es evaluar la utilidad de la ecografía abdominal en el diagnóstico de esta entidad.

**Método:** Estudio retrospectivo realizado entre enero y junio del 2004 de todas las consultas realizadas en el servicio de urgencias por dolor abdominal indicativo de probable abdomen agudo, en los que se realizó una ecografía abdominal para descartar apendicitis aguda.

**Resultados:** Se realizaron 2.015 ecografías abdominales urgentes de las cuales 296 fueron solicitadas para descartar el diagnóstico de apendicitis aguda, de éstas 288 fueron valorables. En 52 pacientes la ecografía fue indicativa de apendicitis aguda. En 15 casos el diagnóstico ecográfico fue discordante con el diagnóstico final. En 6 pacientes el informe ecográfico de apendicitis no se confirmó *a posteriori*. En 9 casos la ecografía fue no diagnóstica pese al diagnóstico quirúrgico de apendicitis aguda. Con estos datos, el rendimiento global de la ecografía para el diagnóstico de apendicitis aguda, se tradujo en una sensibilidad del 83,7%, especificidad del 97,4%, valor predictivo positivo del 87,7%, valor predictivo negativo del 96,2%.

**Conclusiones:** El rendimiento global de la ecografía abdominal en el diagnóstico de apendicitis aguda en nuestro medio es aceptable. Debido a su accesibilidad y bajo coste es la prueba idónea para el diagnóstico en urgencias, sobre todo en casos dudosos. [*Emergencias* 2008;20:81-86]

**Palabras clave:** Apendicitis aguda. Abdomen agudo. Ecografía abdominal.