

## The use of ultrasonography to assess patients with right lower quadrant pain in the emergency department

在急症室使用超聲波造影術評估右下腹痛的病者

AYC Siu 蕭粵中 and CH Chung 鍾展鴻

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Acute appendicitis is always a clinical challenge to emergency physicians. Clinical examination or blood tests are notoriously unreliable in making the diagnosis, especially in the early phase of the disease. Computed tomogram can facilitate the diagnosis, however it is usually not easily accessible to emergency physicians. Bedside ultrasonography is now frequently used by emergency physicians in various situations for the assessment of patients. This study aimed at exploring the potential use of bedside ultrasonography in the diagnosis of acute appendicitis in patients presenting with right lower quadrant abdominal pain. (*Hong Kong j.emerg.med.* 2007;14:70-73)

急性闌尾炎總是急症科醫生的一個臨床挑戰。臨床檢查或血液測試在診斷上是極不可靠，尤其是疾病的初期。電腦掃描可以幫助診斷，但急症科醫生通常是容易得以使用。臨床超聲波造影術現已經常地被急症科醫生應用在各種評估病人的情況下。本研究旨在探索臨床超聲波造影術對呈現右下腹痛的病者作急性闌尾炎診斷的潛在效用。

**Keywords:** Appendicitis, diagnosis, ultrasonography

**關鍵詞：**闌尾炎、診斷、超聲波造影術

### Introduction

Acute appendicitis is a surgical emergency commonly encountered in the emergency department (ED). It can be difficult to arrive at the diagnosis especially in the early phase of the disease. Furthermore, a negative laparotomy is not uncommon even in the hands of experienced surgeons. Ultrasonography is a non-invasive diagnostic tool and is commonly available in the ED. It has been widely used in many conditions, such as ureteric colic, early pregnancy complication

and deep vein thrombosis. The technique of utilising ultrasonography in diagnosing acute appendicitis has been in use for more than ten years. However, its use is still not widely practised in our local setting. This study aimed at exploring the potential of using this technique in diagnosing acute appendicitis in the ED.

### Methods

This was a prospective study and cases were included subject to the availability of the investigator. Patients presenting with right lower quadrant pain and with at least one of the following features were recruited: rebound tenderness or guarding at the right lower quadrant, fever or a typical history of shifting abdominal pain from the central abdomen to the right lower quadrant. Patients with confirmed diagnosis of urinary tract infection, ureteric colic or pelvic inflammatory disease were excluded.

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Correspondence to:

Siu Yuet Chung, Axel, FRCSEd, FHKCEM, FHKAM(Emergency Medicine)  
North District Hospital, Accident & Emergency Department,  
9 Po Kin Road, Sheung Shui, N.T., Hong Kong  
Email: ycasiu@doctors.org.uk

Chung Chin Hung, FRCS(Glasg), FHKAM(Surgery), FHKAM(Emergency Medicine)

Ultrasonography was performed by the first author. A 7.5 MHz probe was placed over the most tender site of the abdomen with graded compression technique. A positive scan was defined as the outer diameter of the appendix greater than 6 mm and incompressible. Localised ileus or local collection of peritoneal fluid detected was also considered as positive scan.

The attending emergency physician would decide whether the patient should be admitted into the surgical ward or observed in the observation ward. For the admitted cases, the diagnoses on discharge were confirmed from the hospital computer Clinical Management System (CMS). The CMS was used to trace patients discharged from the observation ward for any readmission following their discharge. The final diagnosis was compared with the finding of the bedside ultrasonography.

## Results

From January 2004 to May 2006, 85 patients were recruited (M: 45; F: 40). Their age ranged from 8 to 85 (mean: 31.6). The characteristics of their presenting symptoms and signs are listed in Table 1. Twenty-seven patients were documented as positive on ultrasound, of which, eighteen were ultimately confirmed to have acute appendicitis. Fifty-eight patients were found to have negative scan but eleven of them were diagnosed to have acute appendicitis after admission. The sensitivity and specificity were 62.1% and 83.9% respectively. The positive and negative predictive values were 66.7% and 81.0% respectively. The overall accuracy was 76.5%.

Among the nine false positive cases, five patients were operated and were confirmed to have other diagnoses

– 3 acute diverticulitis of the caecum, 1 intestinal obstruction and 1 Meckel's diverticulum. The remaining four patients were not operated on and their symptoms subsided after admission. They were all discharged with a diagnosis of non-specific abdominal pain.

No patient was readmitted to any Hospital Authority hospital within one week after discharge from the observation ward. They were all presumed to be negative for acute appendicitis in the final diagnosis.

## Discussion

Acute appendicitis is a common surgical emergency encountered in the ED. In USA, it was estimated that there were 250,000 cases per year with a life time risk of about 7%.<sup>1</sup> It can be a difficult clinical diagnosis to make especially during the early phase of the disease. On the other hand, a wrong pre-operative diagnosis may also lead to unnecessary exposure to the risks of anaesthesia and operative complications. The negative laparotomy rate may be as high as 15%.<sup>2</sup>

The accuracy of clinical examination was reported to be 70% to 87% but was lower in children and women of childbearing age.<sup>3</sup> The sensitivity of using both the right lower quadrant abdominal pain and tenderness as a criteria was reported to be only 68.8%.<sup>4</sup> Other clinical tools have been employed, which include complete blood count, Alvarado's score and computed tomogram. However the specificity of raised white cell count and raised neutrophil count were low in detecting acute appendicitis.<sup>5</sup> The inflammatory markers were also not useful and the results were usually not readily available.<sup>6</sup> Computed tomogram showed a more promising result with sensitivity and specificity ranging from 76% to 96% and 85% to 92% respectively.<sup>7,8</sup> However, it was not usually accessible to emergency physicians. These diagnostic tools used in the emergency setting are limited by their availability, sensitivity and accuracy.

The use of ultrasonography in detecting acute appendicitis was first reported in 1981.<sup>9</sup> The technique

**Table 1.** Clinical presentation and physical findings

	Yes	No
Typical clinical history	15	70
Guarding	28	57
Rebound tenderness	42	43
Fever	20	65

usually begins by searching the ascending colon which will appear as a non-peristaltic structure filled with gas and liquid. The terminal ileum is then traced by moving the scanning probe inferiorly until you find a tubular structure which is compressible and shows peristalsis. The caecal tip is approximately 1 to 2 cm below the terminal ileum and here is where one try to search for the appendix.<sup>10</sup> Besides this traditional method, another group of investigators attempt to visualise the right psoas and the iliac vessels in a transverse plane first. They are then used as landmarks for identifying the appendix which is usually located between these structures and the abdominal wall.<sup>11</sup>

A diagnosis of acute appendicitis is usually considered if the appendix is non-compressible and its outer diameter is 6 mm or above on cross section.<sup>12</sup> However, it has been reported that the diameter may be up to 11 mm in a normal adult in rare cases.<sup>11</sup> Other supportive sonographic signs include loculated pericaecal fluid, phlegmon (an ill-defined layered structure of the appendiceal wall) or abscess, presence of appendicolith, absence of appendiceal peristalsis, prominent peri-caecal fat and circumferential loss of the submucosal layer.<sup>13,14</sup> The appendiceal wall thickness had also been considered as a useful criteria but it was limited by the fact that their measurement may be erroneously thicker by the inclusion of the adjacent intraluminal pus.<sup>15</sup> Other authors suggested the use of pinpoint tenderness on the abdomen to compare with the site of the suspected pathological finding detected on ultrasound. A positive scan would be made if they were consistent.<sup>16</sup>

Subsequent meta-analyses showed that the sensitivity and specificity of ultrasonography were 84 to 86% and 81 to 92 respectively.<sup>17,18</sup> The use of power Doppler ultrasonography and contrast-enhanced power Doppler

ultrasonography have also been shown to be promising in the diagnosis of acute appendicitis.<sup>19</sup>

Previous studies revealed that emergency physicians had successfully used this technique.<sup>20</sup> In experienced hands, the sensitivity and specificity of ultrasonography were comparable to those of computed tomogram though there were more inconclusive results with ultrasonography.<sup>21</sup> The main pitfalls of graded compression technique included that it was operator-dependent, and the visualisation of the appendix might be difficult in obese patient or in retrocaecal appendix.<sup>22,23</sup> Occasionally, false positive cases were encountered and some authors suggested that they might represent those mild cases which eventually resolved spontaneously.<sup>23,25</sup>

A grading system was proposed by a Japanese group to document the severity of the appendicitis according to the appearance of the echogenic submucosal layer (Table 2).<sup>26</sup> Other adjuvant techniques including the use of posterior manual compression or the left lateral-oblique decubitus position could further improve the detection of retrocaecal or retrocolic appendices.<sup>22,27</sup>

Bedside ultrasonography is now widely available in most of the EDs in Hong Kong. The examination is not invasive and can be repeated anytime when the patient is under observation. It can also help us to identify pathology other than acute appendicitis. However, the test is operator dependent and may be time consuming. The identification of the appendix is more difficult in the obese patient. Currently, our result did not support bedside ultrasonography to be used alone to safely rule out acute appendicitis, upon the current experience level. Some of the early acute appendicitis may be easily missed if the ultrasound signs have not been well developed yet. However, our experience on using this technique is still inadequate,

**Table 2.** Correlation of the ultrasound finding of the appendix with the severity of acute appendicitis<sup>26</sup>

Grade	Submucosal layer appearance	Estimated severity of appendicitis
I	Thin & smooth	Early
II	Thick & smooth	Suppurative
III	Thick & irregular or thin & intermittent	Suppurative to gangrenous
IV	Unidentifiable	Gangrenous

and further practice is required to acquire more experience to improve the accuracy.

## Conclusion

Bedside ultrasonography is readily available in many hospital EDs and is a non-invasive tool that can be useful in making the diagnosis of acute appendicitis especially when the clinical signs are equivocal. Unfortunately, the test is operator-dependent. Based on our current level of skills and experience, it cannot be the sole tool to rule-in or rule-out acute appendicitis accurately. Serial clinical examination and other investigations should be used when the diagnosis is in doubt.

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