Accuracy of Ultrasonography in the Diagnosis of Peritonitis Compared With the Clinical Impression of the Surgeon

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Hypothesis: Peritonitis is a well-known indication for surgery, but its preoperative cause usually is not established. We hypothesize that abdominal ultrasonography is superior to the clinical impression of the surgeon in detecting the cause of peritonitis.

Design: A prospective case series.

Setting: A major university hospital in Taiwan, Republic of China.

Patients and Methods: One hundred two patients with a diagnosis of peritonitis admitted to the Department of Emergency Medicine, National Taiwan University Hospital, Taipei, were included in this study. All 102 patients underwent an abdominal ultrasonographic examination; and the ultrasonographic findings of these patients were classified into 2 categories: positive findings and normal screening results. The accuracy of clinical impression in detecting the cause of peritonitis was compared with the accuracy of abdominal ultrasonography.

Results: Ultrasonography and clinical impression accurately diagnosed the peritonitis in 85 (83.3%) and 52 (51.0%) of the patients, respectively. The difference between ultrasonography and clinical impression in the diagnosis of peritonitis was significant (P<.001). Among 45 patients without a preoperative clinical diagnosis, a diagnosis was made by ultrasonography for 32 (71%) of them. There were a total of 98 patients with positive ultrasonographic findings, and 4 patients had normal screening results. Of the 98 patients with positive ultrasonographic findings undergoing surgery, all had abdominal pathological characteristics. The 4 patients with normal screening results received nonoperative treatment.

Conclusions: Ultrasonography is a more sensitive technique than clinical judgment in diagnosing peritonitis. Ultrasonography may be a useful diagnosing modality in patients with peritonitis in whom the clinical cause is unclear.


A CONCERNING fraction of patients who present with acute abdominal pain have peritonitis. Peritonitis refers to any inflammation of the peritoneal layers, and it is an emergency condition that frequently requires surgery. Not every underlying cause of peritonitis is diagnosed before surgery, and laparotomy has, therefore, traditionally been advised to treat the patient’s disease and to determine the nature of the abdominal pathological features. However, some medical conditions may mimic acute peritonitis, which do not require surgical intervention. Should surgeons operate immediately and face the possibility of finding a nonsurgical condition at laparotomy, or should they observe and risk missing the optimal time for surgery?

Unnecessary laparotomy has been reported to be associated with increased morbidity and prolonged hospitalization.1-3 To reduce the rate of unnecessary laparotomy, additional sensitive and specific examinations are needed to screen patients for operative indications before surgery. Plain radiography, laparotomy, computed tomography, and ultrasonography have been used to aid in the diagnosis of peritonitis. To our knowledge, the role of the abdominal ultrasonographic examination in patients with peritonitis has not been well reported. This prospective study compared the diagnostic accuracy of abdominal ultrasonography with the clinical impression of the surgeon in diagnosing peritonitis.
PATIENTS AND METHODS

All patients with peritonitis admitted to the Department of Emergency Medicine, National Taiwan University Hospital, Taipei, Taiwan, Republic of China, from August 1996 through March 1999, were included in this prospective study. Those patients with abdominal injury were excluded. The study included 102 patients (68 male and 34 female patients). The age of these patients ranged from 13 to 83 years (mean, 47 years).

When patients arrived at the hospital, they were examined by a member of the surgical house staff. After obtaining a detailed medical history and performing a physical examination, venous blood from each patient was sampled and a plain abdominal radiograph or a chest radiograph was obtained. The clinical diagnosis of peritonitis is defined as a patient having diffuse abdominal tenderness, rebounding pain, and leukocytosis. If peritonitis was diagnosed, the presumed cause was recorded, which was blinded from the ultrasonographer, and the patient then underwent an abdominal ultrasonographic examination performed by a staff surgeon. This surgeon had 6 years of experience in performing abdominal ultrasonographic examinations. Ultrasonography was performed with a handheld 3.75-MHz curved-array transducer (model SSA-340A; Toshiba, Tochigi-Ken, Japan) over the whole abdomen, with screening of the pleural space, hepatorenal recess, paracolic gutter, rectouterine pouch, liver, biliary tract, gallbladder, spleen, pancreas, small intestine, colon, and intra-abdominal fluid collections. The epigastric area was first screened to check the antrum, the first portion of the duodenum, and the pancreas; then screening was shifted to the right hypochondriac region and subcostal area to check the liver, the gallbladder, and the right pleural space. The presence of free air was checked in both regions. Following this, the right paracolic gutter was examined to check the ascending colon, the terminal ileum, and the appendix. Then the rectouterine pouch and the left subcostal area were investigated to check the pelvic condition, the spleen, and the left pleural space. The left paracolic gutter was screened next to check the descending colon. Finally, the central abdomen was examined to check the small intestine.

The results of the ultrasonographic examination were categorized as either a positive ultrasonographic finding or a normal screening result. A positive ultrasonographic finding was defined as any additional or abnormal ultrasonographic changes in the abdominal cavity. The ultrasonographic diagnosis was also recorded. The decision to operate was based on the presence of or highly suspected surgical disease found by ultrasonography. Those with normal screening results were hospitalized for close observation and continued investigation. Additional tests, including panendoscopy or computed tomography, were performed to search for an underlying cause of peritonitis in those patients with normal ultrasonographic screening results. The relation between operative findings and ultrasonographic findings was examined in the assessment of the diagnostic accuracy of ultrasonography. The statistical difference in this study was determined by the $\chi^2$ test. $P<.05$ was considered significant.

RESULTS

The findings of the abdominal ultrasonographic examination are shown in Table 1. The ultrasonographic diagnoses of 102 patients with peritonitis are shown in Figure 1. There were 98 patients with positive ultrasonographic findings and 4 patients with normal screening results. The cause of the peritonitis in 85 patients was accurately diagnosed by ultrasonography. Incorrect ultrasonographic diagnoses were found in 5 patients, including 2 with pneumoperitoneum, 2 with internal bleeding, and 1 with perforated appendicitis. The intraoperative findings in patients who underwent laparotomy were as follows:

<table>
<thead>
<tr>
<th>Type of Disease</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perforated duodenal ulcer</td>
<td>32</td>
</tr>
<tr>
<td>Perforated gastric ulcer</td>
<td>25</td>
</tr>
<tr>
<td>Perforated appendicitis</td>
<td>13</td>
</tr>
<tr>
<td>Colonic perforation</td>
<td>9</td>
</tr>
<tr>
<td>Intestinal perforation</td>
<td>3</td>
</tr>
<tr>
<td>Diverticulitis rupture</td>
<td>5</td>
</tr>
<tr>
<td>Intra-abdominal abscess</td>
<td>5</td>
</tr>
<tr>
<td>Acute cholecystitis</td>
<td>3</td>
</tr>
<tr>
<td>Ischemic bowel</td>
<td>2</td>
</tr>
<tr>
<td>Intestinal leiomyosarcoma</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>98</td>
</tr>
</tbody>
</table>

The 4 patients with normal screening results received conservative treatment, and 3 of them underwent an additional panendoscopic examination and were found to have a peptic ulcer without perforation or obstruction. They received a hydrogen blocker and antacid treatment and were followed up at the outpatient clinic. One of these patients underwent abdominal computed tomography, which showed no abnormalities. She received conservative treatment and was discharged from the hospital 2 days later, after her abdominal pain ceased. The symptoms of all 4 patients with normal screening results resolved without surgery, and recovery was verified at the outpatient clinic 2 weeks later.

Among the 57 patients with a preoperative clinical impression (Figure 2), 5 (9%) of these diagnoses were changed based on ultrasonographic findings, including 3 cases of pneumoperitoneum and 2 cases of perforated appendicitis. Ultrasonographic diagnoses were also made in 32 of the remaining 45 patients without a previous clinical impression (Table 2). In the 102 patients, an accurate diagnosis was made based entirely on the clinical impression in 52 patients (51.0%) and based entirely on ultrasonographic examination results in 85 patients (83.3%) ($P<.001$). These results clearly show that ultrasonography is a more sensitive modality than clinical judgment in detecting the cause of peritonitis.

The most common ultrasonographic findings were ascites, dilated small-bowel loop with wall thickness, pneumoperitoneum, thickness of the antrum or duodenal wall, perforated appendicitis with perifocal exudate accumulation, and abscess formation.
Peritonitis continues to be one of the major abdominal emergencies confronting surgeons. The prognosis of peritonitis is poor, especially when multiple organ failure or sepsis develops. The wide range of causes and varied patient presentations pose a formidable diagnostic and therapeutic challenge to the surgeon. Common causes include intra-abdominal inflammation, hollow organ perforation, trauma, bowel ischemia, and bowel obstruction. Regardless of the causes of peritonitis, immediate laparotomy to achieve source control and peritoneal toilet is the most important part of treatment for preventing subsequent serious intra-abdominal sepsis. However, conservative treatment is reserved for those patients with peritonitis that is caused by other medical conditions. Identification of those cases of peritonitis that will not benefit from surgery is necessary.

The diagnostic workup of the peritonitis always begins with a precise history taking, a complete physical examination, and laboratory studies. The approach to examining patients with peritonitis via diagnostic imaging may change when improved outcomes have been demonstrated. Inherent in the evaluation of new technology applied to peritonitis is how tests can avoid a misdiagnosis or provide an earlier disposition of peritonitis. The goal of an imaging study as a diagnostic aid in peritonitis should be to search for the presence of surgical disease. In addition, it should be quick, relatively noninvasive, cost-effective, easily accessible, and accurate in the diagnosis of peritonitis.

Commonly performed additional imaging studies include plain radiography, laparoscopy, ultrasonography, and computed tomography. These imaging modalities should be used to investigate a specific concern and not as a replacement for clinical judgment. Plain radiographs of the abdomen may be helpful in the examination of the patient with acute abdominal pain. A single radiographic view of the abdomen is rarely of help. The usual collection of radiographic views of the abdomen obtained includes an upright chest radiograph. An inspection should be performed for detecting the presence of free intraperitoneal air, air in the retroperitoneum, patterns of gas distention, air-fluid levels, foreign bodies, fecaliths, and stones. Free intraperitoneal or retroperitoneal air is a definitive diagnosis of hollow organ perforation or abscess formation, and the other findings are used for adjuvant diagnosis.

Laparoscopy has been advocated as a diagnostic modality in the examination of a patient with acute abdominal pain. Although directly visualizing the abdominal cavity might be a valid method of determining the focus of the inflammation, patients preceded to surgery or without any abnormal findings would be exposed to the risks and costs of general anesthesia and diagnostic
laparoscopy. Several researchers\textsuperscript{14-17} have advocated the use of computed tomography as the imaging test of choice in diagnosing peritonitis. However, computed tomography is associated with greater cost, exposure to ionizing radiotherapy, and exposure to contrast medium.\textsuperscript{18} Computed tomography may be more or less identify separted peritoneal fluid, parietal peritoneum thickening, and infiltration of the mesenteric or omental fat, fluid-filled dilated loop; it may also demonstrate bowel wall edema and obviate the need for laparotomy.\textsuperscript{14}

Abdominal ultrasonography has become a diagnostic procedure of increasing importance in patients with acute abdomen.\textsuperscript{19-24} Various reports\textsuperscript{19-21,24} have shown its benefit in surgical emergencies when a diagnosis has to be determined rapidly. This study was performed to evaluate the diagnostic sensitivity of abdominal ultrasonography in the diagnosis of peritonitis. In a previous study,\textsuperscript{23} ultrasonographic screening led to an earlier diagnosis, but the length of hospitalization was not reduced. In this study of 102 patients, a preoperative ultrasonographic examination accurately detected the cause of peritonitis in 85 (83.3\%), whereas an accurate diagnosis was made for only 52 (51.0\%) based on history taking, physical examination results, and laboratory findings. Thus, an ultrasonographic examination significantly improved preoperative diagnostic sensitivity (P<.001). Although a preoperative diagnosis can be determined in some patients, ultrasonography still fails to reveal the underlying cause in some patients. For example, ultrasonography can demonstrate pneumoperitoneum, but identification of the site of hollow organ perforation by ultrasonography is difficult. All 98 patients with positive ultrasonographic findings underwent laparotomy and were found to have intra-abdominal pathological features that confirmed the positive ultrasonographic findings. This demonstrated that ultrasonography is a reliable screening modality for peritonitis and that a normal ultrasonographic screening result excludes the likelihood of intra-abdominal pathological features.

Abdominal ultrasonography in patients with peritonitis provides the physician with another stethoscope to check the abdominal condition. It is the single most effective test for noninvasive exploration of the abdomen. The reasons for performing abdominal ultrasonography in patients with peritonitis include: (1) to identify the abdominal pathological features, such as perforating appendicitis, acute cholecystitis, ascites, or pneumoperitoneum; (2) to prevent unnecessary treatment or examination, such as unnecessary laparotomy or enema study to determine the presence of toxic megacolon; (3) to provide sufficient information to allow the initiation of the treatment, such as surgery or close observation and further examination; and (4) to evaluate the process of disease to determine whether the disease has progressed or improved. Preoperative knowledge of the causes of peritonitis has the advantages of enabling the formation of a detailed operative plan, including incision line, operative procedures, surgical instrument preparation, and preoperative instruction to patients and family members. With the aid of ultrasonography, physicians can easily determine the condition of the patient with peritonitis and define appropriate treatment.

In conclusion, real-time ultrasonography is valuable not only for its sensitivity in identifying the underlying pathological process in cases of peritonitis but also for its ability to eliminate certain diagnoses, expedite patient care, and improve resource allocation. In many cases, the patient's medical history, clinical examination results, laboratory findings, and the results of plain radiography of the abdomen or chest suffice to indicate the need for urgent surgery, and an ultrasonographic examination is not indicated in these patients. However, in other cases, when clinical diagnosis is uncertain and treatment is not clear, ultrasonography may identify the precise cause underlying acute abdominal pain that requires surgery. The results of this study suggest that ultrasonography is a useful adjunct in a subgroup of patients with peritonitis whose clinical impression is unclear.

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REFERENCES