

COMPARATIVE EFFICACY OF ULTRASOUND AND X-RAY ABDOMEN IN THE DIAGNOSIS OF NON-TRAUMATIC SMALL BOWEL PERFORATIONS

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ABSTRACT

Background: A non-traumatic small bowel perforation is a medical emergency that needs to be diagnosed promptly. Although the first-line imaging modality has historically been plain X-ray, recently, ultrasonography has become a useful diagnostic tool. This comparative study evaluates the diagnostic efficacy of ultrasound versus plain abdominal radiography in detecting non-traumatic small bowel perforations. The objective is to compare the sensitivity and diagnostic accuracy of ultrasound and plain X-ray abdomen in diagnosing pneumoperitoneum and bowel perforation in patients with non-traumatic small bowel perforations. **Materials and Methods:** Patients with acute abdominal symptoms and suspected non-traumatic intestinal perforation were included in this prospective comparative analysis. Before an exploratory laparotomy, all patients underwent a plain abdomen X-ray (erect chest or lateral decubitus views) and an ultrasound. Surgical findings served as the gold standard for diagnosis. **Result:** X-ray was more sensitive (72.5%) than ultrasonography (67.5%) for diagnosing pneumoperitoneum. While overall diagnostic accuracy was similar across modalities, xray yielded better and cost effective results. **Conclusion:** Ultrasound provides non-radiation diagnosis for pneumoperitoneum detection and can offer extra diagnostic information regarding gut wall integrity and causing pathology, although plain X-ray is still quick and independent of the operator. For non-traumatic small intestinal perforations, a combination strategy that makes use of both modalities maximizes diagnostic accuracy.

INTRODUCTION

Surgical peritonitis is still commonly caused by non-traumatic small intestine perforation, especially in developing nations where infectious etiologies are prevalent.^[1] The condition represents a surgical emergency requiring immediate diagnosis and intervention to minimize morbidity and mortality. Peritoneal signs and pneumoperitoneum constitute components of the traditional clinical presentation, but it is often challenging to diagnose the presence and cause of perforation preoperatively.^[1]

When a small intestinal perforation is suspected, imaging is essential to the diagnostic process. Pneumoperitoneum, or free intra-peritoneal air, has historically been a signature finding on plain abdominal radiography, which has been a hallmark of preliminary imaging.^[2] However, depending on the radiographic technique and imaging settings used, the sensitivity of plain radiography in identifying

pneumoperitoneum varies greatly, with reported sensitivities ranging from 56% to 100%.^[1]

As a non-invasive, non-radiating, bedside modality that can be used at the point of care, ultrasound offers clear advantages over plain radiography, especially in the acute setting.^[2] Computed tomography has been established as the gold standard for detecting and localizing bowel perforation with superior accuracy (82-90% for site localization), but resource limitations in developing countries necessitate evaluation of more accessible modalities.^[1,3] Ultrasound imaging has shown increasing utility in detecting pneumoperitoneum and characterizing bowel pathology.

Patient outcomes are greatly impacted by delay in diagnosing small bowel perforation. The risk of morbidity and mortality rises with every hour that surgical intervention is delayed. Finding pneumoperitoneum is essential because it validates the necessity of immediate surgical investigation. Additionally, accurate imaging may reveal details

regarding the underlying cause, such as enteric fever, neoplastic lesions, or tuberculous disease, which affects long-term care and surgical choices.^[1]

Rapid and precise diagnosis is crucial in the Indian context, where non-traumatic small bowel perforations are primarily caused by enteric fever, TB, and non-specific ileitis.^[1] Given the varying availability of modern imaging technology across various healthcare settings, the choice of imaging modality becomes more crucial.

Objective: In order to enhance the diagnostic algorithm for this surgical emergency, this study compares the diagnostic efficacy of plain abdominal X-ray and ultrasound in identifying pneumoperitoneum and assessing bowel integrity in patients with non-traumatic small bowel perforations.

MATERIALS AND METHODS

It was a prospective study for one and half year in the Department of General Surgery at Christian Medical College and Hospital. All patients above 18 years of age who gave informed consent and undergoing surgery for non-traumatic spontaneous small bowel perforation were included in the study. After detailed history was taken and, thorough clinical examination was done. After resuscitation, the patients underwent exploratory laparotomy under general anaesthesia. Operative findings were noted and edge biopsy from the perforation or the resected specimen was sent for histopathological examination.

The study evaluated two commonly available imaging modalities—plain abdominal radiography and ultrasound—in the same cohort of patients presenting with suspected non-traumatic small bowel perforation.

Inclusion Criteria

- Patients above age of 18 years presenting with acute abdominal pain and clinical signs suspicious for hollow viscus perforation
- Planned exploratory laparotomy for suspected non-traumatic bowel perforation
- Completion of both ultrasound and plain X-ray imaging prior to surgical intervention

Exclusion Criteria

- Traumatic abdominal injuries (blunt or penetrating)
- Duodenal perforations (as primary duodenal pathology may not require biopsy)
- Hemodynamic instability precluding imaging delays
- Pregnancy

Imaging Protocol

Plain Abdominal Radiography

- Standard protocol included erect chest X-ray (posteroanterior view) to detect subdiaphragmatic free air
- Alternatively, left lateral decubitus abdominal X-ray was obtained in patients unable to stand

- Supine abdominal radiography was performed for anatomical orientation and assessment of bowel loops, calcification, or mass lesions

Ultrasound Examination

- Performed with portable ultrasound machines using 3.5-5 MHz linear or curved transducers
- Systematic examination of all four abdominal quadrants
- Assessment for free fluid (ascites), pneumoperitoneum (echogenic foci within peritoneal cavity), bowel wall integrity, and localized bowel pathology
- Imaging findings were recorded systematically including location, extent of free air, bowel wall appearance, and any focal lesions

Statistical Analysis

Data was analyzed using appropriate statistical methods:

- Sensitivity = True Positives / (True Positives + False Negatives)
- P-value <0.05 was considered statistically significant
- Data analysis was performed using SPSS version 16.0 (SPSS Inc., Chicago, Illinois, USA)

RESULTS

Study included 40 adults (>18 years); males predominated at 72.5% (29 patients) vs females 27.5% (11 patients). Age distribution peaked at 21-40 years (42.5%, 17 patients), with 12.5% each (5 patients each) in ≤20 years and >60 years. Etiologies by histopathology: nonspecific ileitis (55%, 22 patients), tuberculosis (20%, 8 patients), neoplasms (12.5%, 5 patients), enteric fever (10%, 4 patients), Meckel's (2.5%, 1 patient), Xray abdomen detected pneumo-peritonium in 72.5 % patients whereas ultrasound detected pneumo-peritonium in 67.5% patients.

DISCUSSION

One of the most frequent surgical catastrophes that can lead to peritonitis, sepsis, and even mortality is hollow viscus perforation.^[7] Therefore, the key to preventing these complications is prompt diagnosis and intervention.^[8] Over the years, the most popular diagnostic imaging technique for diagnosing pneumoperitoneum was plain radiography. The following are the most common signs of an upright abdomen on a plain x-ray.^[10]

1. Cupola sign — commonly present on supine xray, air under center of diaphragm
2. Rigler's sign — Pneumo outline bowel wall.
3. Lucent liver sign – diminished liver opacity by rim of air
4. Football sign — air outside bowel looks like football seen in large perforations
5. Silver's sign — pneumoperitonium aroundfalciform ligament

6. Inverted V sign — Air surrounding lateral umbilical ligaments
7. Doge's cap sign — air in shape of triangle in Morison pouch.

The most sensitive imaging diagnostic for identifying free intraperitoneal air is CT, as is widely recognized.^[6,10] The success rate ranges from 83 to 100 percent, although CT is more costly and generates more radiation than plain radiography, and the patient must be brought to the CT unit. Even with medical advancements, CT scans are still unavailable at Indian district and mission hospitals.

The usefulness of ultrasonography in perforation peritonitis is debatable; some studies indicate that it is more effective than plain x-rays, while others state that it is less effective.^[3-5] On ultrasound, there are a few clear indicators of perforation in which free air is demonstrated in peritoneal cavity whereas in indirect signs free fluid or thickened bowel wall seen.

In a cohort of 40 patients with surgically confirmed non-traumatic small intestinal perforations, our study demonstrated that ultrasound detected perforation in 27/40 patients, yielding a sensitivity of 67.5%, while X-ray indicated pneumoperitoneum in 72.5% (29/40 patients). In instances with minor pneumoperitoneum or sealed perforations, which are common in nonspecific ileitis (55% of cases), the decreased ultrasonic sensitivity compared to X-ray (72.5%) shows limitation in detecting free intraperitoneal air.

In their study, Peiman Nazerian discovered that plain X-rays had a 86% diagnostic accuracy for peritonitis caused by perforation, which is comparable to our study.^[2] Study by Sharma et al. reported that a plain X-ray abdomen was 100% diagnostic accuracy for perforation peritonitis.^[1]

In contrast to our study Ali et reported ultrasound as better diagnostic tool for diagnosis of perforation peritonitis with sensitivity upto 90%.^[12]

Erect chest radiography consistently shows subdiaphragmatic air in 70–80% of perforation cases, as demonstrated in this Indian cohort primarily affecting the ileum (82.5%), which is consistent with X-ray's established first-line imaging for acute abdomen. Despite its strengths in identifying free fluid linked to tubercular (20%) and enteric (10%) etiologies, ultrasound's significant shortfall (missing 13 instances) probably lies in operator dependence and difficulties spotting retroperitoneal gas or small air collections amid bowel gas artifacts.

Specificity and PPV cannot be determined in the absence of false positive data, while research indicates that ultrasound specificity surpasses 88% in

high-prevalence environments such as peritonitis-endemic areas in some studies.^[12] The 5% marginal sensitivity difference makes X-rays a superior diagnostic tool, particularly in facilities with restricted resources.

CONCLUSION

Clinical diagnosis remains cornerstone of perforation peritonitis. Plain xray abdomen is cost effective and superior to ultrasound in diagnosis of perforation peritonitis

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