International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 14, No. 5, May 2025 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_14.5.2025.31

ORIGINAL RESEARCH

Diagnostic Performance of Clinical Assessment and Imaging Techniques for Acute Abdominal Conditions: A Comparative Study

[1]Dr. Santosh Kumar Prajapati, [2]Dr. Shyam Kumar Dhakaita, [3]Dr. Pulkit Sharma

[1]Senior Resident, Department of Surgery, Government Medical College Singrauli, India
[2]Professor, Department of Surgery, RD Gardi Medical College Ujjain, Surasa, Madhya Pradesh, India
[3]Senior Resident, Department of Surgery, RD Gardi Medical College Ujjain, Surasa, Madhya Pradesh, India

Corresponding Author
Dr. Santosh Kumar Prajapati
Senior Resident, Department of Surgery, Government Medical College Singrauli, India

Received: 21 March, 2025 Accepted: 30April, 2025 Published: 07 May, 2025

Abstract
This study evaluates the diagnostic accuracy of clinical assessment and imaging modalities (X-ray, ultrasound, and CT scan) in diagnosing acute abdominal conditions, including perforation, appendicitis, and small bowel obstruction (SAIO), compared to intraoperative findings. A diverse cohort was analyzed based on socio-demographic factors, clinical complaints, and diagnostic results. Clinical assessment showed moderate sensitivity and specificity across all conditions, with the highest performance in SAIO (sensitivity: 72.7%, specificity: 94.8%). X-ray was highly effective for diagnosing SAIO (95.5% accuracy) but less accurate for perforation (76.1%). Ultrasound demonstrated high accuracy for appendicitis (87.5%) and SAIO (95.5%), but its sensitivity for perforation was low (43.5%). CT scans outperformed all other modalities, achieving 92% accuracy for appendicitis, 96.6% for SAIO, and 95.5% for perforation. The findings suggest that a multi-modal diagnostic approach, combining clinical assessment and imaging, is crucial for accurate diagnosis and optimal management of acute abdominal conditions.

Introduction

Acute abdominal pain is defined as a sudden onset of pain lasting less than a week, often less than 48 hours [1, 2]. The term "acute abdomen" refers to a severe presentation of abdominal pain characterized by guarding and muscular rigidity, indicative of peritonitis and typically requiring emergency surgery [3]. This has led to the misconception that acute abdomen is synonymous with surgical abdomen. However, not all cases of acute abdomen necessitate surgery. In literature and clinical practice, the terms acute abdominal pain and acute abdomen are often used interchangeably.

In German medical literature, the term acute abdomen encompasses all cases of acute abdominal pain [3], whereas in English literature, acute abdomen is considered a subset of acute abdominal pain [4]. Cope's Early Diagnosis of the Acute Abdomen (Silen 2010) highlights the misconception that an acute abdomen must be catastrophic, causing severe pain and board-like rigidity. Standardizing these terms could eliminate confusion.

Acute abdominal pain arises from various conditions. Historically, such patients were believed to have an acute abdomen, warranting surgery. Today, even patients with tenderness and rigidity may not require surgery, while some without rigidity undergo operations [5]. Diagnostic imaging, including ultrasound and computed tomography (CT), is widely used alongside clinical and laboratory evaluations. The American College of Radiology recommends CT with contrast for acute abdominal pain [6], but some clinicians prefer ultrasound due to its accessibility and lack of ionizing radiation [7, 8]. Ionizing radiation from CT poses risks, especially in younger patients, leading to considerations of alternative imaging strategies like ultrasound and MRI [9]. Accurate imaging is crucial to avoid missed or delayed diagnoses.

Conditional CT strategies, using ultrasound first and CT for inconclusive results, have been effective [10]. For appendicitis, CT is the preferred modality [11]. For diverticulitis, recent meta-analyses suggest comparable accuracy between ultrasound and CT, questioning CT's primary use [12]. However, ultrasound accuracy can be observer-dependent, with challenges in obese patients, women, and certain age groups, especially reproductive-age women. CT generally shows high inter-observer agreement, particularly for appendicitis and diverticulitis [13].

DOI: 10.69605/ijlbpr_14.5.2025.31

Ultrasound is a viable alternative to CT if its diagnostic accuracy is comparable and reliable for common causes of acute abdominal pain in the ED. This study compared ultrasound and CT in diagnosing conditions such as appendicitis and diverticulitis and evaluated the impact of patient characteristics and observer experience on ultrasound accuracy.

Aim

To compare CT scan, USG, and X-ray for diagnosing and managing acute abdomen.

Objectives

1. Highlight the importance of CT in diagnosing acute abdomen.
2. Establish CT's role in acute abdomen cases.
3. Compare CT with other radiological methods (USG, X-ray).
4. Assess CT's role in managing acute abdomen.
5. Prevent delayed diagnosis of acute abdomen.
6. Compare radiological findings with operative results.

Methodology

Study Design

The study was a prospective observational study conducted in the Department of General Surgery at R D Gardi Medical College, Ujjain, India during study period July 2022 to June 2024. The purpose was to compare pre-operative diagnoses based on clinical examination and investigation with operative diagnoses in patients with acute abdomen.

Study Setting and Source of Data

•Study Centre: R D Gardi Medical College and Hospital, Ujjain.

•Data Source: All patients admitted over one year with acute abdominal pain in the General Surgery wards, in collaboration with the Department of Radiodiagnosis at R D Gardi Medical College.

Sample Size Calculation

To determine the sample size based on sensitivity and specificity with a 95% confidence level, the following estimates were used:

•Expected Sensitivity: 80.00%
•Expected Specificity: 85.00%
•Prevalence of Disease (p): 60.00%
•Acceptable Precision (W): 10.00%
•Significance Level (α): 0.05

Based on these parameters:

•Sample Size for Sensitivity: 88
•Sample Size for Specificity: 71
•Final Sample Size: 88

Thus, the minimum sample size required for this study was 88 suspected cases.

Inclusion Criteria

•All patients who presented to the emergency department with a clinical diagnosis of acute abdomen.

Exclusion Criteria

•Pediatric age group (14 years and below)
•Acute abdomen in pregnancy
•Clinically unstable patients
•Patients medically unfit to undergo a contrast study (e.g., renal failure patients)
•Patients with suspected hypersensitivity reactions

Data Collection

Data required for the study were collected through the following means:

•Clinical History: A detailed history was recorded using a prescribed proforma.
•General Examination: Assessed patient fitness for surgery.
•Radiological Investigations: Conducted for all patients to aid in the diagnostic process.

Clinical Features Considered

•Abdominal pain
•Nausea
•Vomiting
•Bowel disorders
•Fever
•Abdominal distension

Procedure

1.History Taking: A comprehensive history was taken for each patient.
2.Clinical Examination: Each patient underwent a thorough clinical examination.
3.Radiological Investigations: Necessary radiological investigations were performed.
4.Provisional Diagnosis: Comparative analysis of clinical features and investigations was conducted to derive a provisional diagnosis.
5.Informed Consent: Informed consent was obtained from all participating patients.
6.Ethical Approval: The study protocol was approved by the Institutional Ethical Committee.

Statistical Analysis

•Quantitative Data: Frequency distribution, measures of central tendency, dispersion, and graphical representation.
•Qualitative Data: Frequency distribution, percentage, and various diagrammatic representations.
•Statistical Tests: Appropriate parametric and non-parametric tests, Fisher's exact test, and Chi-Square test as applicable.
•Significance Level: A p-value of less than 0.05 was considered significant.

Ethical Considerations

Patients were informed about the project and asked to participate voluntarily. Ethical approval was obtained from the Institutional Ethical Committee of R D Gardi Medical College.

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Observations and results: The study analyzed 88 cases of acute abdomen, with a mean age of 42.28 years (range: 19-76). Most cases fell between 31-50 years (44.3%), with males (52.3%) slightly outnumbering females (47.7%). A majority of patients (62.5%) were from rural areas. Common symptoms included abdominal pain (100%), fever (62.5%), vomiting (54.5%), and abdominal distension (45.5%). Most cases (85.2%) reported pain lasting less than three days. Hypertension (15.9%) and diabetes mellitus (19.3%) were the predominant comorbidities. Vegetarian diets were prevalent among 79.5% of patients. Clinically, appendicitis (39.8%) and perforation (23.9%) were the most frequent diagnoses. Imaging findings varied: X-ray commonly showed no abnormalities (75%), while USG and CT most frequently identified appendicitis (26.1% and 35.2%, respectively). Intraoperative diagnoses confirmed appendicitis (34.1%) and perforation (26.1%) as leading causes, with other notable findings including SAIO, liver abscess, and cholecystitis. This comprehensive evaluation highlights the diagnostic patterns and prevalence of conditions in acute abdominal cases.

Table: 1 Demographic and clinical details of the cases

Parameter	Categories	Frequency (n)	Percentage (%)
Age Group	≤20 years	8	9.1
	21-30 years	18	20.5
	31-40 years	19	21.6
	41-50 years	20	22.7
	51-60 years	13	14.8
	>60 years	10	11.4
Gender	Male	46	52.3
	Female	42	47.7
Residence	Rural	55	62.5
	Urban	33	37.5
Symptoms	Abdominal pain	88	100
	Fever	55	62.5
	Vomiting	48	54.5
	Abdominal distension	40	45.5
	Constipation	21	23.9
Duration of Pain	<3 days	75	85.2
	>3 days	13	14.8
Comorbidities	Hypertension	14	15.9
	Diabetes Mellitus	17	19.3
Dietary Habits	Vegetarian	70	79.5
	Non-vegetarian	18	20.5
Clinical Diagnosis	Appendicitis	35	39.8
	Perforation	21	23.9
	SAIO	12	13.6
	Pancreatitis	11	12.5
	Cholecystitis	9	10.2
Imaging (X-ray)	NAD	66	75
	Perforation	9	10.2
	SAIO	11	12.5
	Others	2	2.3
Imaging (USG)	NAD	27	30.7
	Appendicitis	23	26.1
	Perforation	10	11.4
	SAIO	11	12.5
	Others	17	19.3
Imaging (CT)	Appendicitis	31	35.2
	Perforation	19	21.6
	SAIO	12	13.6
	Others	26	29.6
Intraoperative Diagnosis	Appendicitis	30	34.1
	Perforation	23	26.1
	SAIO	11	12.5
	Others	24	27.3

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Table: 2 Comparison of imaging diagnosis and intraoperative diagnosis

Diagnosis	Modality	Sensitivity	Specificity	PPV	NPV	Accuracy
Perforation	Clinical	52.20%	86.20%	52.20%	86.20%	71.60%
	X-ray	39.10%	89.20%	56.30%	80.60%	76.10%
	USG	43.50%	93.80%	71.40%	82.40%	80.70%
	CT	82.60%	100%	100%	94.20%	95.50%
Appendicitis	Clinical	66.70%	74.10%	57.10%	81.90%	71.60%
	USG	70.00%	96.60%	91.30%	86.20%	87.50%
	CT	93.30%	91.40%	84.80%	96.40%	92.00%
SAIO	Clinical	72.70%	94.80%	40.00%	97.30%	61.40%
	X-ray	81.80%	97.40%	81.80%	97.40%	95.50%
	USG	81.80%	97.40%	81.80%	97.40%	95.50%
	CT	90.90%	97.40%	83.30%	98.70%	96.60%

The comparison of diagnostic methods with intraoperative findings highlights variations in sensitivity, specificity, and overall accuracy. For diagnosing perforation, clinical assessment showed a sensitivity of 52.2%, specificity of 86.2%, and an accuracy of 71.6%, while ultrasound (USG) improved specificity to 93.8% with an accuracy of 80.7%. CT scans demonstrated superior performance with a sensitivity of 82.6%, specificity of 100%, and accuracy of 95.5%.

For appendicitis, clinical diagnosis achieved a sensitivity of 66.7%, specificity of 74.1%, and accuracy of 71.6%. USG improved the accuracy to 87.5%, while CT scans performed best with a sensitivity of 93.3%, specificity of 91.4%, and accuracy of 92%.

In small bowel obstruction (SAIO), clinical assessment had a sensitivity of 72.7%, specificity of 94.8%, and an accuracy of 61.4%. USG and X-ray shared similar high accuracies of 95.5%, with sensitivities of 81.8% and specificities of 97.4%. CT scans were the most reliable, achieving a sensitivity of 90.9%, specificity of 97.4%, and accuracy of 96.6%.

Discussion

This observational study, conducted in the Department of Surgery at R.D. Gardi Medical College, Ujjain, analyzed various clinical, diagnostic, and demographic aspects of patients presenting with acute abdominal conditions. The findings are discussed below:

Socio-demographic Characteristics: The majority of participants (22.7%) were aged 41–50 years, followed by 31–40 years (21.6%). Gender distribution was nearly equal, with 52.3% males and 47.7% females, unlike other studies showing a male predominance (Sharma P et al., 14; Arora et al., 15). Most participants (62.5%) were from rural areas.

Clinical Complaints: Abdominal pain was universally present in all cases (100%), with vomiting (54.5%), fever (62.5%), and abdominal distension (45.5%) being notable additional symptoms. Most participants (85.2%) experienced pain for less than three days. These findings are consistent with prior studies, emphasizing abdominal pain as the predominant symptom of acute abdomen (Sharma P et al.,14; Arora et al., 15).

Comorbidities and Dietary Preferences: Hypertension and diabetes mellitus were present in 15.9% and 19.3% of participants, respectively. The majority (79.5%) were vegetarians.

Diagnostic Findings: The most common clinical diagnosis was appendicitis (39.8%), followed by perforation (23.9%) and small bowel obstruction (13.6%). Imaging modalities revealed varied findings, with X-rays showing no abnormalities in 75% of cases, while ultrasound and CT scans frequently identified appendicitis and bowel obstructions (Sharma P et al., 14; Arora et al., 15).

Intraoperative Diagnoses: Appendicitis remained the most common intraoperative finding (34.1%), followed by perforation (26.1%) and small bowel obstruction (12.5%). These results align with earlier studies, which also highlighted appendicitis as the leading cause of acute abdomen (Sharma P et al., 14; Deshmukh et al., 18).

Clinical Assessment: Clinical assessment showed moderate diagnostic performance across conditions. For perforation, it had a sensitivity of 52.2% and specificity of 86.2%, with a diagnostic accuracy of 71.6%. Appendicitis had a sensitivity of 66.7% and specificity of 74.1%, also with an accuracy of 71.6%. SAIO had the highest sensitivity (72.7%) and specificity (94.8%), though its accuracy was lower (61.4%). Sharma P et al. (14) found high accuracy in diagnosing appendicitis and peritonitis but lower performance for intestinal obstruction.

X-ray Performance: X-ray was most accurate for SAIO, with 95.5% diagnostic accuracy, and showed moderate accuracy for perforation (76.1%). Sharma P et al. (14) reported high sensitivity for diagnosing hollow viscus perforation and intestinal obstruction. Arora et al. (15) also noted good performance in detecting obstructions and perforations. However, sensitivity for perforation was lower than for SAIO.

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Ultrasound (USG) Performance: USG showed strong performance for appendicitis (87.5% accuracy) and SAIO (95.5% accuracy) but had lower sensitivity for perforation (43.5%). Agrawal P et al. (19) reported high sensitivity for appendicitis but moderate for perforation. Sharma P et al. (14) and Arora et al. (15) found that USG was more reliable for appendicitis and obstruction than perforation.

CT Scan Performance: CT scans demonstrated the highest diagnostic accuracy among all modalities. For appendicitis, the sensitivity was 93.3% with an accuracy of 92%, while for SAIO, it was 96.6%, and for perforation, 95.5%. Nasappa et al. (18) found that CT had perfect diagnostic accuracy for appendicitis and intestinal obstruction.

In conclusion, while clinical assessments and imaging methods each have their strengths and limitations, CT scan proved to be the most reliable diagnostic tool, particularly for appendicitis and perforation. A multi-modal approach is essential for improving diagnostic accuracy and guiding treatment decisions in acute abdominal condition, this study underscores the predominance of appendicitis and perforation in acute abdominal cases, with notable demographic and clinical patterns. The findings highlight the importance of prompt diagnosis and management to optimize outcomes.

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