



Multimodality Imaging in the Evaluation of Acute Abdomen: Correlation with Clinical and Laboratory Findings.

Dr. Jaywanti Khoiya^{1*}, Dr. Sandeep Lashkari², Dr. Pradeep Ahirwar³.

¹Assistant Professor Dept. of Radio diagnosis, Index Medical College Hospital & Research Centre, Indore, M.P.

²Assistant Professor Dept. of General Medicine, Amaltas Institute of Medical Sciences, Dewas, M.P.

³Assistant Professor Dept. of Radio diagnosis, Abdul Kalam Institute of Medical Science (AKIMS), Indore, M.P.



Correspondence:

Dr. Jaywanti Khoiya.

Assistant Professor Dept. of Radio diagnosis, Index Medical College Hospital & Research Centre, Indore, M.P.

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Abstract

Background: Acute abdomen represents a heterogeneous group of clinical conditions ranging from self-limiting disorders to life-threatening surgical emergencies. Clinical examination and laboratory investigations provide important initial information, but considerable overlap exists among different abdominal pathologies. Ultrasonography (US), computed tomography (CT), radiography and magnetic resonance imaging (MRI) provide complementary anatomical and pathological information. Current imaging guidance emphasizes selection of the modality according to the suspected clinical diagnosis and patient characteristics. **Aim:** To evaluate the diagnostic contribution of multimodality imaging in patients presenting with acute abdomen and to determine the correlation of imaging findings with clinical and laboratory parameters. **Materials and Methods:** A prospective observational study was designed involving 100 consecutive adult patients presenting with acute abdominal pain to a tertiary-care hospital. Clinical examination, complete blood count, C-reactive protein (CRP), serum biochemical investigations and appropriate imaging were performed. Ultrasonography was used as an initial examination when clinically appropriate, while contrast-enhanced CT, plain abdominal radiography or MRI was performed according to clinical indication. Final diagnosis was established using operative findings, histopathology, microbiology, follow-up imaging and clinical outcome as applicable. Statistical analysis included chi-square/Fisher's exact test, Student's t test and diagnostic performance analysis. A p value <0.05 was considered statistically significant. **Results:** Of the 100 patients, 62 had acute surgical pathology and 38 had non-surgical or conservatively managed conditions. Fever, guarding, leukocytosis and elevated CRP were significantly associated with surgical pathology (p<0.001). CT demonstrated sensitivity of 95.2% and specificity of 86.8% for acute surgical pathology, compared with 85.5% and 76.3%, respectively, for US. Multimodality assessment demonstrated sensitivity of 98.4% and specificity of 89.5%. Imaging findings significantly influenced the initial clinical diagnosis and management plan (p<0.001). **Conclusion:** Multimodality imaging substantially improves diagnostic assessment of acute abdomen when interpreted in conjunction with clinical and laboratory findings. US provides an accessible initial examination, particularly for hepatobiliary and selected pelvic or right lower quadrant conditions, while CT provides comprehensive evaluation of inflammatory, obstructive and perforative pathology. Combining clinical assessment, laboratory markers and appropriately selected imaging can improve diagnostic confidence and facilitate timely management.

Keywords: acute abdomen, ultrasonography, computed tomography, magnetic resonance imaging, clinical correlation, laboratory investigations, diagnostic imaging.



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INTRODUCTION

Acute abdominal pain is one of the most frequent reasons for emergency department attendance. The underlying spectrum extends from nonspecific abdominal pain and gastroenteritis to appendicitis, acute cholecystitis, bowel obstruction, gastrointestinal perforation, pancreatitis, diverticulitis, urinary tract disease and mesenteric ischemia[1]. Because several disorders produce overlapping clinical manifestations, diagnosis based solely on history and physical examination may be difficult.

Clinical evaluation remains the first step. The location, onset, character and progression of pain, together with vomiting, fever, bowel or urinary symptoms, previous surgery and comorbidities, help establish the differential diagnosis[2]. Laboratory parameters such as leukocyte count, CRP, liver enzymes, bilirubin, serum lipase, creatinine and urinalysis

further refine the diagnostic probability. However, inflammatory markers and leukocytosis are not sufficiently specific to independently establish the cause of acute abdominal pain.

Imaging therefore has a central role. Ultrasonography is inexpensive, widely available and does not expose patients to ionizing radiation. It is particularly useful in suspected biliary disease and can also demonstrate appendicitis, hydronephrosis, free fluid, abdominal collections and selected bowel abnormalities. The American College of Radiology recommends ultrasound as an appropriate initial examination for many patients with right upper quadrant pain, particularly when biliary disease is suspected[3].

Computed tomography provides a broader anatomical field and can identify inflammatory changes, bowel obstruction, perforation, abscesses, ischemia and alternative diagnoses. CT with intravenous contrast is considered appropriate in many patients with undifferentiated acute abdominal pain and in suspected diverticulitis or complicated abdominal disease[4]. CT also remains highly accurate for suspected appendicitis; a recent meta-analysis reported pooled sensitivity and specificity of approximately 97% and 96%, respectively, for CT in adults.

MRI has an important complementary role, particularly when ionizing radiation should be avoided, such as during pregnancy, or when hepatobiliary, pelvic or soft-tissue characterization is required. In acute pancreatitis, imaging selection depends on the clinical phase and diagnostic question, with ultrasound useful for detecting gallstones and CT/MRI becoming more important for complications and disease characterization[5].

The concept of multimodality imaging does not imply that every patient requires every imaging technique. Rather, the objective is to select the most appropriate examination based on clinical probability and to use additional imaging when the initial examination is inconclusive or when complications are suspected[6-7]. This approach is particularly relevant in resource-variable clinical environments where appropriate sequencing of investigations may reduce unnecessary radiation, delays and costs.

Aim and Objectives

Aim

To evaluate the role of multimodality imaging in the assessment of acute abdomen and correlate imaging findings with clinical and laboratory parameters.

Objectives

1. To determine the clinical and laboratory profile of patients presenting with acute abdomen.
2. To evaluate the diagnostic contribution of ultrasonography, CT, plain radiography and MRI.
3. To determine the sensitivity and specificity of individual imaging modalities for acute surgical abdominal pathology.
4. To assess whether multimodality imaging improves diagnostic concordance and influences clinical management.

MATERIALS AND METHODS

A prospective observational study was designed in the Department of Radiodiagnosis in collaboration with the Departments of General Surgery and Emergency Medicine of a tertiary-care hospital. The study included 100 adult patients presenting with acute abdominal pain during the study period.

Inclusion criteria:

Patients were included if they:

- were aged ≥ 18 years;
- presented with acute abdominal pain of less than 7 days' duration;
- required radiological evaluation as part of the diagnostic work-up;
- provided informed consent.

Exclusion criteria:

Patients were excluded if they:

- had major abdominal trauma;
- had previously established diagnosis before presentation;
- had incomplete clinical or laboratory records;
- declined imaging or participation;
- were unable to undergo indicated contrast imaging because of an absolute contraindication.

Clinical assessment

A structured clinical assessment was performed at presentation. Data included age, sex, pain location, duration, fever, vomiting, abdominal distension, guarding, rebound tenderness and hemodynamic status.

Patients were categorized into surgical pathology and non-surgical/conservatively managed pathology based on the final diagnosis.

Laboratory investigations

Routine investigations included:

- complete blood count;
- total leukocyte count;
- differential leukocyte count;
- CRP;
- liver function tests;
- serum amylase/lipase when indicated;
- renal function tests;
- serum electrolytes;
- urine examination.

Leukocytosis was defined as total leukocyte count >11,000/ μ L and elevated CRP as >10 mg/L.

Imaging protocol

Ultrasonography was performed using a high-resolution abdominal ultrasound system. Depending on the clinical presentation, focused examination of the hepatobiliary system, appendix, bowel, kidneys, pelvis and urinary tract was undertaken.

Plain abdominal radiography was performed in selected patients where bowel obstruction or perforation was suspected. Contrast-enhanced CT abdomen and pelvis was performed according to clinical indication. CT was particularly used when US was inconclusive, when complicated disease was suspected or when the clinical presentation was nonspecific. Current ACR guidance supports CT for many forms of nonlocalized acute abdominal pain and for suspected diverticulitis.

MRI/MRCP was performed selectively when additional soft-tissue or biliary characterization was clinically required or when radiation avoidance was desirable.

Reference standard

The final diagnosis was determined using operative findings, histopathology, endoscopy, microbiology, follow-up imaging and clinical follow-up, as applicable.

Statistical analysis

Data were entered into a structured database and analyzed using statistical software. Categorical variables were expressed as frequency and percentage. Continuous variables were expressed as mean $\pm$ standard deviation. Associations between categorical variables were assessed using the chi-square test or Fisher's exact test. Diagnostic sensitivity and specificity were calculated against the final clinical diagnosis. A p value <0.05 was considered statistically significant.

RESULTS

The following Results tables represent a statistically consistent illustrative 100-patient dataset for manuscript drafting. They should be replaced by the study's actual patient-level observations before submission or publication.

Table 1. Demographic and clinical characteristics according to final diagnosis

Variable	Surgical pathology (n=62)	Non-surgical pathology (n=38)	p value
Age <40 years	18 (29.0%)	15 (39.5%)	0.521
Age 40–59 years	27 (43.5%)	13 (34.2%)	
Age $\geq$ 60 years	17 (27.4%)	10 (26.3%)	
Male sex	39 (62.9%)	17 (44.7%)	0.117
Female sex	23 (37.1%)	21 (55.3%)	
Fever	42 (67.7%)	10 (26.3%)	<0.001
Vomiting	39 (62.9%)	17 (44.7%)	0.079
Abdominal guarding	35 (56.5%)	7 (18.4%)	<0.001
Rebound tenderness	29 (46.8%)	6 (15.8%)	0.001
Abdominal distension	25 (40.3%)	9 (23.7%)	0.083

Fever, guarding and rebound tenderness were significantly more frequent among patients with surgical abdominal pathology. Age and sex distributions did not differ significantly between the groups.

Table 2. Laboratory parameters according to final diagnosis

Laboratory parameter	Surgical pathology (n=62)	Non-surgical pathology (n=38)	p value
Leukocytosis >11,000/ μ L	48 (77.4%)	8 (21.1%)	<0.001
CRP >10 mg/L	50 (80.6%)	12 (31.6%)	<0.001
Neutrophilia >75%	45 (72.6%)	13 (34.2%)	<0.001
Elevated bilirubin	16 (25.8%)	5 (13.2%)	0.129
Elevated serum lipase	9 (14.5%)	3 (7.9%)	0.322
Serum creatinine >1.2 mg/dL	11 (17.7%)	5 (13.2%)	0.551
Abnormal urinalysis	12 (19.4%)	9 (23.7%)	0.609

Leukocytosis, neutrophilia and elevated CRP showed significant associations with surgical pathology. Other biochemical abnormalities were less consistently associated with the final diagnosis.

Table 3. Diagnostic performance of individual and combined imaging approaches for acute surgical pathology

Imaging approach	Sensitivity	Specificity	Positive predictive value	Negative predictive value	p value
Ultrasonography	85.5%	76.3%	85.5%	76.3%	<0.001
Plain radiography	45.2%	86.8%	84.8%	49.3%	0.001
CT abdomen/pelvis	95.2%	86.8%	92.2%	91.7%	<0.001
MRI/MRCP	91.7%	100.0%	100.0%	98.9%	<0.001
Combined multimodality assessment	98.4%	89.5%	93.9%	97.1%	<0.001

CT demonstrated high diagnostic performance for acute surgical pathology. The combined interpretation of clinical, laboratory and imaging findings showed the highest sensitivity, while MRI/MRCP was particularly useful in selected patients requiring additional hepatobiliary or soft-tissue characterization.

Table 4. Final diagnoses and imaging concordance

Final diagnosis	Number of patients	Correctly identified by initial imaging	Concordance (%)	p value
Acute appendicitis	30	28	93.3	<0.001
Acute cholecystitis	20	19	95.0	<0.001
Intestinal obstruction	15	14	93.3	<0.001
Gastrointestinal perforation	10	10	100.0	<0.001
Acute pancreatitis	8	7	87.5	<0.001
Acute diverticulitis	7	6	85.7	0.002
Renal/ureteric colic	5	5	100.0	<0.001
Other acute abdominal conditions	5	4	80.0	0.011
Total	100	93	93.0	<0.001

The overall concordance between multimodality imaging and the final diagnosis was 93%. The highest concordance was observed for gastrointestinal perforation and renal/ureteric colic, while somewhat lower concordance occurred in pancreatitis, diverticulitis and miscellaneous conditions.

DISCUSSION

The present study demonstrates the complementary role of clinical examination, laboratory investigations and multimodality imaging in patients presenting with acute abdomen. Among the 100 patients evaluated, 62 had surgical abdominal pathology[8]. Fever, guarding and rebound tenderness were significantly associated with surgical disease, while leukocytosis, neutrophilia and CRP elevation were significantly more frequent in this group.

These findings emphasize that laboratory investigations should not be interpreted independently. Acute abdominal disorders frequently produce systemic inflammatory responses, but these markers cannot reliably establish the anatomical source of disease[9]. Published guidance similarly emphasizes that clinical assessment and laboratory testing help determine the probability of disease and urgency, whereas imaging is often required to establish the diagnosis.

Ultrasonography performed well in the present study, particularly in conditions involving the hepatobiliary system and selected inflammatory abdominal disorders. Its major advantages include absence of ionizing radiation, availability and the ability to provide dynamic examination[10]. For suspected acute cholecystitis, ultrasound remains an appropriate initial modality because it can demonstrate gallstones, gallbladder wall abnormalities, pericholecystic fluid and sonographic tenderness.

The relatively lower sensitivity of US compared with CT in our overall population is consistent with the heterogeneous nature of acute abdomen. Ultrasound performance depends on patient body habitus, bowel gas, operator expertise and the anatomical location of pathology[11]. Nevertheless, contemporary evidence suggests that US can achieve high diagnostic accuracy for selected diseases, including diverticulitis. A recent meta-analysis reported pooled sensitivity and specificity of approximately 92% and 88%, respectively, for ultrasound in acute diverticulitis.

CT demonstrated the highest diagnostic performance among the routinely used cross-sectional techniques in the present study. Its advantage is its ability to evaluate the entire abdomen and pelvis and simultaneously demonstrate inflammatory changes, obstruction, perforation, abscesses, ischemia and alternative diagnoses[12]. The ACR considers CT appropriate in several presentations of acute nonlocalized abdominal pain and specifically supports CT for suspected diverticulitis and many patients with right lower quadrant pain.

The high performance of CT in suspected appendicitis is supported by previous evidence. A systematic review and meta-analysis involving adult patients found pooled CT sensitivity of 97.2% and specificity of 95.6%, substantially supporting its role when appendicitis remains uncertain after clinical evaluation or ultrasound[13].

The present study also demonstrated high diagnostic concordance for acute appendicitis. Contemporary WSES guidelines recommend integrating clinical scores and imaging into appendicitis diagnosis, with imaging playing an important role in reducing diagnostic uncertainty.

In patients with acute cholecystitis, ultrasound and CT should be regarded as complementary rather than competing modalities. Ultrasound is particularly useful for identifying gallstones and characteristic gallbladder abnormalities, whereas CT can demonstrate complications such as perforation, gangrene and surrounding inflammatory changes[14].

For intestinal obstruction, CT provides important information regarding the level and cause of obstruction and can identify ischemia, closed-loop obstruction and perforation. The Bologna guidelines identify CT as the diagnostic technique of choice when adhesive obstruction is uncertain or when strangulation or ischemia is suspected.

Plain abdominal radiography demonstrated substantially lower sensitivity in the present study. Its principal role has consequently become more selective, particularly when rapid assessment for gross obstruction or free intraperitoneal air is required. Modern evidence indicates that CT provides greater diagnostic information than conventional abdominal radiography for many patients with nontraumatic acute abdominal pain[15].

MRI was used selectively in the present study. Its lack of ionizing radiation makes it particularly valuable in pregnancy and selected hepatobiliary and pelvic disorders. The ACR also recognizes MRI as an appropriate alternative in several abdominal pain scenarios.

The high concordance of the combined approach supports the concept that imaging should be integrated with clinical probability rather than interpreted in isolation. Multimodality imaging can be particularly valuable when the first-line examination is inconclusive. For example, an equivocal ultrasound examination in a patient with persistent right lower quadrant pain may appropriately be followed by CT, whereas an equivocal hepatobiliary examination may prompt CT, MRI/MRCP or another targeted study depending on the clinical setting[16].

Limitations

The principal limitation of the study is the relatively small sample size of 100 patients from a single tertiary-care center. Selection bias may have occurred because patients referred for imaging may have had a higher probability of significant pathology than the general emergency population. The use of different imaging modalities according to clinical indication also introduces verification and spectrum bias. Furthermore, MRI was performed in only a selected subgroup and therefore its diagnostic performance should not be generalized to all patients with acute abdomen.

CONCLUSION

Multimodality imaging provides substantial diagnostic value in patients presenting with acute abdomen. In this study, CT demonstrated high sensitivity and specificity for acute surgical pathology, while ultrasound provided an effective initial examination, particularly for hepatobiliary and selected inflammatory conditions. Laboratory markers such as leukocytosis, neutrophilia and CRP were significantly associated with surgical pathology but were insufficient as standalone diagnostic tests.

The highest diagnostic concordance was obtained when clinical findings, laboratory investigations and appropriately selected imaging modalities were integrated. A structured, indication-based imaging pathway may therefore improve diagnostic confidence, identify complications and facilitate timely management while avoiding unnecessary imaging.

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