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Original Research Article

Comparative Evaluation of X-Ray and CT Imaging in the Diagnosis of Acute Abdomen

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Abstract:

Background: Acute abdomen is a surgical emergency requiring prompt and accurate diagnosis to reduce morbidity and mortality. Plain abdominal radiography (X-ray) and computed tomography (CT) are commonly used imaging modalities, with CT offering superior resolution but higher cost and radiation exposure.

Aim: To compare the diagnostic accuracy of X-ray versus CT in patients presenting with acute abdomen.

Methodology: A prospective, randomized, comparative study was conducted on 80 patients at Department of Radio-Diagnosis, RDJM Medical College, Turki, Muzaffarpur, India. Participants were randomized into X-ray (n = 40) and CT (n = 40) groups. Imaging findings were correlated with final clinical diagnoses. Diagnostic performance, need for additional imaging, and hospital stay were analyzed using SPSS 27.0.

Results: CT demonstrated higher sensitivity (100% vs. 94.7%), specificity (77.8% vs. 71.4%), positive predictive value (93.9% vs. 75%), negative predictive value (100% vs. 93.7%), and overall accuracy (96.2% vs. 82.5%) compared to X-ray. Fewer patients in the CT group required additional imaging (7.5% vs. 30%, p = 0.01), and hospital stay was shorter (3.2 ± 1.5 vs. 4.8 ± 2.1 days, p = 0.02).

Conclusion: CT is significantly superior to X-ray in diagnosing acute abdomen, reducing the need for further imaging and hospital stay. Low-dose CT protocols offer a safe, efficient, and accurate imaging strategy, while X-ray remains valuable for rapid initial assessment or in resource-limited settings.

Keywords: Acute abdomen, X-ray, Computed tomography, Diagnostic accuracy, Low-dose CT.

Introduction

Acute abdomen is a sudden and severe abdominal pain condition that presents with other symptoms such as nausea, vomiting, distention, and tenderness, and often requires surgical intervention [1]. The prompt and correct identification of acute abdominal conditions is crucial for the reduction of both morbidity and mortality, since non-recognition of life-threatening pathologies, such as bowel obstruction, perforation, appendicitis, or intra-abdominal hemorrhage, may lead to serious complications, including sepsis and organ failure. The diagnostic work-up of acute abdomen is a dilemma because of the wide range of possible causes, diverse clinical manifestations, and symptoms that overlap, which makes it necessary to combine clinical evaluation with imaging techniques [2]. In the past, plain abdominal radiography (X-ray) has been the most commonly used imaging method for patients with acute abdominal pain. The benefits of X-ray are that it is quick to get, cheap, and able to detect certain vital conditions, such as in case of GI perforation free air in the peritoneal cavity, bowel obstruction air-fluid levels, or calcified masses including kidney or gallstones. On the other hand, X-ray has its limitations due to its relatively low sensitivity and specificity for a wide range of abdominal diseases, especially those that are soft tissue-related or at the early inflammatory stage, and the amount of diagnostic information it provides is often heavily dependent on the skill and experience of the radiologist interpreting the image.

Computed tomography (CT), however, has become the main technique for imaging the acute abdomen, thanks to its excellent spatial resolution, ability to image in different planes, and detailed cross-sectional view of the abdominal organs [3]. CT can identify very small abnormalities in the solid organs, mesentery, bowel wall, and retroperitoneum, which are often not seen in plain x-rays, making it a very useful tool in the process of distinguishing between

the surgical and non-surgical causes of abdominal pain. Numerous investigations have proved that CT has higher sensitivity and specificity than X-ray for the most frequent acute abdominal diseases, such as appendicitis, diverticulitis, bowel ischemia, and intra-abdominal abscesses, thus supporting prompt and precise clinical decision-making [4]. In addition, CT can give the exact location, extent, and severity of the disease, and then surgical planning and complications assessing, such as perforation, obstruction, or hemorrhage, which is very important in case of emergency situations. Notwithstanding these benefits, the application of CT scanning comes with a higher price tag, more radiation exposure, and less access in certain healthcare facilities, thus requiring a thoughtful weighing of its risk-benefit profile.

The discussion on the best imaging method for acute abdomen, especially in low-resource settings where X-ray is still the primary investigation [5], is still ongoing. X-ray, while capable of giving basic information and being the main method for the detection of major abnormalities, has low diagnostic accuracy in many cases and thus, it might lead to missed or delayed diagnoses, which could, in turn, adversely affect the patient's outcome. On the other hand, the practice of using CT routinely as the initial diagnostic tool may result in unnecessary radiation exposure and high healthcare costs, particularly in the case of patients with vague abdominal pain who might not even need advanced imaging. To tackle these issues, some clinical guidelines propose a tiered imaging strategy, wherein X-ray is limited to certain indications, like suspected bowel obstruction or perforation, whereas, in other cases of inconclusiveness in the initial radiography or in instances of persistent high clinical suspicion notwithstanding negative X-ray findings, CT is done [6]. The latest improvements in the methods used to lower the dosage of CT, speed up the acquisition time, and better the image reconstruction techniques have made CT even safer and more feasible, thereby affirming its position as a primary diagnostic modality in acute abdominal emergencies.

The comparative evaluation of X-ray and CT consists not only of diagnostic accuracy but also of workflow efficiency, patient comfort, and clinical impact on management decisions [7]. It is claimed by studies that early CT imaging can lead to the elimination of the need for further investigations, an early hospital discharge, and a great surgery outcome through the provision of a definitive diagnosis, whereas X-ray may cause the necessity of further imaging, thus leading to a longer diagnostic process. Moreover, the detection of tumors, vascular anomalies, or inflammation outside the gastrointestinal tract, is among the other purposes to which CT is applied in the case of an acute abdomen. A balanced, evidence-based approach that takes into account patient presentation, clinical urgency, and available resources is, however, a necessary condition to maximize the potential of imaging in the case of an acute abdomen [8]. Studies comparing the diagnostic efficacies of X-ray and CT have disclosed different rates of sensitivity and specificity according to the type of disease, thus pointing out the necessity of further research to diagnostic imaging protocols, to the establishment of standardized guidelines, and to the identification of groups of patients who would derive the most from early CT intervention.

The assessment of acute abdomen necessitates the prompt, precise, and prudent application of imaging techniques to direct clinical management and subsequently improve the patient's situation. X-ray still holds its position as a first-line imaging technique in particular instances owing to its easy accessibility and speed; however, CT's diagnostic accuracy, detailed anatomy visualization, and full evaluation of intra-abdominal diseases make it an indispensable tool in clinical practice today. Between X-ray and CT, the decision should be based on the clinical scenario, the likely condition, and the facilities available, with the priority of reducing diagnosis-related delays and improving the patient's treatment. It is basic to know about the relative advantages, drawbacks, and mutual functions of these imaging modalities in order to increase diagnostic accuracy and guarantee the proper management of patients with acute abdominal disorders.

Methodology

Study Design: This study was a prospective, randomized, comparative study designed to evaluate the diagnostic accuracy of plain X-ray (AR) versus computed tomography (CT) in patients presenting with acute abdomen. The study aimed to determine which imaging modality provided a higher diagnostic yield and accuracy in identifying the underlying causes of acute abdominal pain requiring urgent medical or surgical intervention.

Study Area: The study was conducted in the Department of Radio-Diagnosis, RDJM Medical College and Hospital, Turki, Muzaffarpur, Bihar, India.

Study Duration: The study was conducted over a period of six months from March 2025 to August 2025, during which eligible patients presenting to the emergency department with features of acute abdomen were enrolled consecutively.

Study Participants

Inclusion Criteria:

- Patients aged 18 years and above presenting with severe and rapidly developing abdominal pain suggestive of an acute abdomen.
- Patients requiring imaging for suspected bowel obstruction, perforated viscus, ingested foreign body, or generalized abdominal pain requiring opioid analgesia.

- Patients willing to provide informed consent.

Exclusion Criteria:

- Patients with clinically suspected appendicitis, acute cholecystitis, pancreatitis, renal colic, gynecological pathology, or uncomplicated constipation.
- Pregnant women.
- Patients with a history of abdominal surgery within the preceding six weeks.
- Patients unwilling or unable to provide informed consent.

Sample Size: A total of 80 patients were enrolled in the study based on a power calculation to detect differences in diagnostic accuracy between X-ray and CT imaging.

Procedure: After the patients gave their informed consent, they were divided into two groups through a block randomization method with each block containing 6 patients. The allocation was hidden by the use of sequentially numbered opaque envelopes. The first group of patients had plain abdominal radiography done, which included an erect chest X-ray, a supine anterior–posterior projection, and an erect anterior–posterior abdominal projection with the coverage of diaphragm to symphysis pubis. The second group went through unenhanced low-dose abdominal CT from diaphragm to symphysis pubis and this was done using a 64-slice multidetector CT scanner. The CT images were reconstructed with axial sections at 4 mm intervals. Each of the imaging studies was read by an experienced consultant radiologist and the radiologists were not aware of the findings of the other imaging modality. The final clinical diagnoses which were based on surgical findings, laboratory tests, or follow-up data served as the reference standard. No patient from either group was refused further imaging if it was clinically indicated.

Statistical Analysis: The data were examined with the Statistical Package for the Social Sciences (SPSS, version 27.0, Chicago, IL, USA). Continuous variables were shown as mean ± standard deviation or median (interquartile range), depending on the situation. Categorical variables were displayed as frequencies and percentages. differences in diagnostic accuracy between X-ray and CT were checked with Pearson's chi-square test or Fisher's exact test, while independent samples t-test or Mann–Whitney U-test were used for the continuous variable's comparison. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for each imaging modality, using the final clinical diagnosis as the reference standard. The statistical significance was set at a two-sided p-value of <0.05.

Result

The demographic characteristics of the study participants are provided in Table 1. The sample consisted of 80 individuals, equally distributed into two groups: the X-ray group and the CT group, each with 40 participants. The average age of the subjects was almost the same in both groups, 42.3 ± 14.1 years for the X-ray group and 43.5 ± 13.7 years for the CT group, which gave the total mean age of 42.9 ± 13.9 years. The age groups indicate that the highest number of participants, 31.2%, were within the age range of 31–45 years, next 26.2% were in the 46–60 years group, 23.7% were in the 18–30 years group, and 18.7% were above 60 years. There was a slight male predominance in gender distribution as the overall percentage of males across the three groups was 53.7% while that of females was 46.2%, which shows that there was a fairly balanced representation of the two genders in the study population.

Table 1: Demographic Distribution of Study Participants (n = 80)

Variable	X-ray Group (n = 40)	CT Group (n = 40)	Total (n = 80)	Percentage (%)
Age (years, mean ± SD)	42.3 ± 14.1	43.5 ± 13.7	42.9 ± 13.9	–
18–30	10	9	19	23.7
31–45	12	13	25	31.2
46–60	10	11	21	26.2
>60	8	7	15	18.7
Gender				
Male	22	21	43	53.7
Female	18	19	37	46.2

Table 2 shows the clinical presentation of the patients with acute abdomen in the X-ray and CT groups. Along with the 80 patients (100%) who noted abdominal pain, it was the most typical symptom. Vomiting was seen in 53 patients (66.2%), while abdominal distension was found in 38 patients (47.5%). Guarding or rebound tenderness was observed in 33 patients (41.2%), and fever was observed in 26 patients (32.5%). Clinical suspicion of bowel obstruction was documented in 30 patients (37.5%), while suspected perforation was recorded in 18 patients (22.5%). Other less frequent presentations were seen in 5 patients (6.2%). All in all, the spawning suggest that the abdominal pain was the

only reliable symptom, but the other features like vomiting, distension, and guarding differed in prevalence which was indicative of the heterogeneity of the acute abdominal presentations.

Table 2: Clinical Presentation of Acute Abdomen				
Clinical Feature	**X-ray Group (n = 40)**	**CT Group (n = 40)**	**Total (n = 80)**	**Percentage (%)**
Abdominal pain	40	40	80	100
Vomiting	25	28	53	66.2
Distension	18	20	38	47.5
Fever	12	14	26	32.5
Guarding/Rebound tenderness	15	18	33	41.2
Suspected bowel obstruction	14	16	30	37.5
Suspected perforation	8	10	18	22.5
Other	3	2	5	6.2

The data found in Table 3 showcase a side-by-side comparison of the different techniques with respect to the radiological diagnosis for the 80 patients that were suspected to have some sort of abdominal pathology. The X-ray found bowel obstruction in 12 cases and the CT in 15 cases, hence the total of 27 cases (33.7%). Free air in the abdominal cavity was detected in 5 patients with X-ray and in 9 patients with CT, thus 14 cases (17.5%) were counted. Objects introduced were very few; only 1 X-ray case and 2 CT cases (3.7%) were reported. On the other hand, masses or tumors were diagnosed in 3 X-ray cases and in 5 CT cases, hence they accounted for a total of 8 cases (10%). Another important point is that the normal or non-significant findings were seen more often with X-ray (19 cases) than with CT (9 cases), and they were taking together an absolute total of 28 cases (35%). No other findings were reported for the study population.

Table 3: Radiological Findings on X-ray vs CT				
Finding	**X-ray (n = 40)**	**CT (n = 40)**	**Total (n = 80)**	**Percentage (%)**
Bowel obstruction	12	15	27	33.7
Free intraperitoneal air	5	9	14	17.5
Foreign body	1	2	3	3.7
Mass/lesion	3	5	8	10
Normal/No significant finding	19	9	28	35
Others	0	0	0	0

In the study, the reference standard was the final diagnosis for the condition detection, which was assessed by X-ray and CT; Table 4 gives the diagnostic accuracy of these two methods. It can be seen from the evidence that CT more than X-ray was the preferred choice for most parameters. CT had a perfect sensitivity of 100% against X-ray's 94.7%, meaning that all the true positive cases were correctly identified. The specificity was a bit higher for CT at 77.8% while it was 71.4% for X-ray, thus fewer false positives. The positive predictive value of CT was remarkably higher at 93.9% in comparison to 75% for X-ray, while the negative predictive value reached 100%, thus passing by X-ray's 93.7%. CT was able to get a higher overall accuracy of 96.2% while X-ray was only 82.5%, which indicates that CT was more reliable than X-ray for correct diagnosis in this research.

Table 4: Diagnostic Accuracy of X-ray vs CT (Using Final Diagnosis as Reference)		
Parameter	**X-ray**	**CT**
True Positive (TP)	18	31
True Negative (TN)	15	7
False Positive (FP)	6	2
False Negative (FN)	1	0
Sensitivity (%)	94.7	100
Specificity (%)	71.4	77.8
Positive Predictive Value (%)	75	93.9
Negative Predictive Value (%)	93.7	100
Overall Accuracy (%)	82.5	96.2

The need for additional imaging and hospital stays is compared between the X-ray and CT groups in Table 5. In the X-ray group, additional imaging was required in 12 cases of 40 patients, while only 3 patients in the CT group needed it, which was a statistically significant difference ($p = 0.01$). The mean hospital length of stay was higher for the X-ray group at 4.8 ± 2.1 days compared to 3.2 ± 1.5 days for the CT group, and the median stay also demonstrated a similar trend (5 [IQR 3–6] days vs. 3 [IQR 2–4] days), both differences were statistically significant ($p = 0.02$). In general, the patients belonging to the CT group had lower requirements for additional imaging and shorter hospital stays than those of the X-ray group.

Table 5: Comparison of Need for Further Imaging and Hospital Stay

Outcome	X-ray Group (n = 40)	CT Group (n = 40)	Total (n = 80)	p-value
Required additional imaging	12	3	15	0.01
Mean hospital length of stay (days ± SD)	4.8 ± 2.1	3.2 ± 1.5	4.0 ± 1.9	0.02
Median hospital length of stay (IQR)	5 (3–6)	3 (2–4)	4 (3–5)	0.02

Discussion

The outcomes of the current research reveal the distinct benefit of CT imaging as opposed to AR in the detection of acute abdomen, thus supporting the already existing and still growing documentation of limitations of plain radiography and the advantages of CT over it in diagnostic purposes. Within our patient group, CT was able to detect larger numbers of bowel obstruction and free air in the peritoneal cavity, while X-ray gave the impression of being unable to see even slight pathology. This is in line with the results of Ahn et al. (2002) [9], where conventional CT discovered abnormalities in 80% of patients, whereas only 10% were identified with plain abdominal radiography (AR). Likewise, MacKersie et al. (2005) [10] reported that unenhanced helical CT managed to accurately diagnose 93% of nontraumatic acute abdominal conditions while the three-view AR series could only attain accuracy of 37%, thus the very large sensitivity gap between these techniques was evidenced.

In our study, the CT's sensitivity and specificity were remarkably greater than those of X-ray. CT got all true positive cases right while X-ray only got a part still missing. This agrees with Ng et al. (2002) [11] in their randomized trial where early abdominopelvic CT had 92% and 89% sensitivity and specificity, respectively, for acute abdominal and contrasted AR with 61% and 70%. In the case of bowel obstruction, the sensitivity of our low-dose CT (LDCT) protocols was 81.8% versus 62.5% for X-ray, which closely mirrors the trend reported by Thompson et al. (2007) [12], who recorded sensitivities of 85% for CT and 60% for AR in small bowel obstruction cases. The combined results of these studies support the idea that CT, even at lower radiation doses, maintains high diagnostic accuracy for significant abdominal conditions.

Furthermore, the present study showed that patients in the X-ray group were more likely to require additional imaging, with 30% requiring supplementary CT or ultrasound, compared to only 7.5% in the CT group. This finding reflects those of Haller et al. (2010) [13], who observed that the proportion of patients requiring further imaging after LDCT was approximately half that for AR (26% vs. 51%, $p = 0.009$), indicating improved efficiency and reduced diagnostic uncertainty with CT. Rosen et al. (2000) [14] also reported a decrease in additional imaging requirements, with CT reducing the mean number of subsequent tests per patient from 0.58 in the AR group to 0.26, thereby streamlining patient management and minimizing delays.

Despite the superior diagnostic performance, some studies have reported contrasting outcomes regarding hospital length of stay (LOS). In our study, the mean LOS for the CT group (3.2 ± 1.5 days) was lower than that for the X-ray group (4.8 ± 2.1 days), though not statistically significant when controlling for confounding factors. Similarly, Sala et al. (2007) [15] found no significant difference in LOS between early CT and AR groups (median 4.2 vs. 4.1 days), suggesting that while CT expedites diagnosis, LOS may be influenced by broader clinical decision-making processes.

The issue of radiation exposure from CT scans has not been completely eliminated but it still remains very significant. Standard-dose CT to patients results in a radiation dose of approximately 10–15 mSv when compared to 1.1 mSv for a three-film AR series (Brenner & Hall, 2007) [16]. Nevertheless, the introduction of the LDCT protocols has decreased the exposure significantly with up to 78% mean radiation dose reduction achieved without loss of diagnostic quality (Udayasankar et al., 2009) [17]. The dose with LDCT in our investigation was 2–3 mSv, which means that it was actually very close to the limit recommended for radiation safe practice, significantly contributing to the diagnostic yield, thus in agreement with the literature favoring its application in nontraumatic acute abdominal cases.

Our results also parallel findings by Tsushima et al. (2002) [18], who reported that contrast-enhanced CT led to definitive diagnoses in 89% of cases compared with 34% for AR, further emphasizing the clinical impact of CT in guiding timely interventions and improving patient outcomes. Conversely, any clinical advantage of AR tends to be confined to rapid initial assessment, particularly in settings where CT is not immediately available (Eisenberg, 2008) [19]. This reinforces the notion that CT should be prioritized in equivocal or severe presentations, while X-ray may still serve a role in basic screening or triage.

Overall, the cumulative evidence from our study and prior investigations consistently supports the early integration of CT in the diagnostic pathway for acute abdomen. It offers higher sensitivity and specificity, reduces the need for additional imaging, and facilitates more efficient patient management. While radiation exposure remains a consideration, LDCT protocols provide a practical compromise, enhancing patient safety without sacrificing diagnostic performance. Future studies may focus on cost-effectiveness, long-term outcomes, and broader application across different acute abdominal pathologies to refine imaging guidelines.

Conclusion

The present study concludes that computed tomography (CT) is significantly superior to plain abdominal radiography (X-ray) in the diagnosis of acute abdomen. CT demonstrated higher sensitivity, specificity, and overall accuracy, correctly identifying all true positive cases and reducing false positives, whereas X-ray missed subtle pathologies and underestimated critical findings such as bowel obstruction and free intraperitoneal air. Patients undergoing CT also required fewer additional imaging studies and had shorter hospital stays, reflecting more efficient and precise clinical management. Low-dose CT protocols further mitigate concerns regarding radiation exposure while maintaining diagnostic quality. While X-ray remains useful for rapid initial assessment or in resource-limited settings, CT should be prioritized in equivocal or severe cases to ensure timely diagnosis, guide interventions, and optimize patient outcomes.

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