

Role of computed tomography in non-traumatic acute abdomen in adults



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ABSTRACT

Background: The objective of this study was to study, assess, and diagnose causes of acute abdomen accurately, to determine the accuracy of multidetector computed tomography (CT) for confirmation of negative, diagnosed, or equivocal ultrasonography (USG) cases, and to establish role of CT as the primary imaging modality. **Aims and Objective:** To study, assess and diagnose causes of acute abdomen accurately, To determine the accuracy of MDCT for confirmation of Negative, diagnosed or equivocal USG cases & To establish role of CT as the primary imaging modality. **Materials and Methods:** One hundred and twenty random patients were included in this prospective study. USG and CT were done in all patients. Axial, coronal, and sagittal reformatted images were studied. Intravenous and oral contrast were also used depending on the clinical condition. All these patients were followed up diagnosis obtained before and after CT were compared with intraoperative findings or final clinical diagnosis at discharge. **Results:** Among 120 patients, confirmative CT diagnosis was made in 111 cases and was discordant in seven cases, while two cases could not be followed up. Forty-five cases underwent surgical management and rest of them were managed medically. **Conclusion:** CT abdomen done in patients presenting with non-traumatic acute abdominal pain which helps to make accurate diagnosis and planning the appropriate treatment.

Key words: Pain abdomen; Multi-detector computed tomography in Bundelkhand; Causes of acute abdomen

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INTRODUCTION

The term acute abdomen is referred to as a condition characterized by severe pain in abdomen which develops in duration of hours and commonly explains acute abdominal pain in a group of patients who are extremely unwell and complains of rigidity and tenderness in abdomen.¹

This can be due to number of reasons ranging from insignificant disease to life-threatening disease. Therefore, the clinical diagnosis of acute abdomen can be challenging, because results of physical examination, clinical presentation, and laboratory examination are often non-specific and non-diagnostic.

The use of conventional radiography (X-rays) has been nowadays of little value with significance being in the setting of bowel obstruction showing dilated bowel loops with air fluid levels.

However, computed tomography (CT) is more accurate and more informative in this setting as well. For this reason, plain radiography is avoided in these situations unless there is the suspicion of perforation or bowel dilatation.

Ultrasonography (USG) has developed a satisfactory role in evaluating the gallbladder in all patients and the appendix in children and pregnant women.

Multidetector CT (MDCT), however, has become the Premier modality for evaluation of the gut, mesenteries, omentum, peritoneum, and retro peritoneum unaffected by the presence of bowel gas and fat.

Aims and objectives

The objectives of this study were as follows:

- To study, assess, and diagnose causes of acute abdomen accurately so as to minimize the chances of

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exploratory laparotomy and unnecessary operations and consequently improved patient care.

- To establish role of CT as the primary imaging modality in the evaluation of acute abdomen in adult patients.
- To determine the contributions of CT in non-traumatic acute abdomen for confirmation of diagnosed or equivocal USG cases, its management and post-operative follow-up.

MATERIALS AND METHODS

After written permission, certification, and approval from the Ethical Committee, the study was conducted in radiodiagnosis department of MLB Medical College Jhansi, Uttar Pradesh (Bundelkhand area) from January 2020 to June 2021.

This prospective study was done on 120 randomly collected patients who were referred to radiology department with Documentation of acute abdomen from Emergency, Surgery, Medicine and Gynecology departments for USG and CT.

Proper data including findings of USG and CT along with relevant patient details were undertaken and compared with final discharge diagnosis.

Philips multidetector 16 Slice CT (MDCT) machine was used for all the cases. The patient in supine position with arms raised above the head and the abdomen is centered within the gantry. Non-enhanced CT abdomen was done from the level of diaphragm through the symphysis pubis within a single breath hold. The raw data are acquired at a section thickness of 0.625 mm; pitch – 0.8–1.5. First, the images are acquired in pre-contrast phase. Then, 1–2 mL/kg of water soluble non-ionic IV contrast medium (Iohexo) with an iodine content of 275–370 mg was given at a rate – 4 mL/sec through a power injector. Then, post-contrast arterial, venous, and delayed phases were taken at 25 s, 45 s, and 7 min, respectively, by bolus tracking and automated triggering technology. In necessary cases, oral contrast was given an hour before the, 30 mL ionic contrast medium containing 250 mg I/mL in 1 L of water. All the patients undergoing contrast scan were screened for renal function and iodine contrast allergies.

RESULTS

In our study, majority 61% of the study population were males with male: female ratio of 1.55:1 and majority (26%) of them presented with the right lower quadrant pain followed by periumbilical (24%) and epigastric quadrant

(19%). Among organs, the bowel was the most commonly involved organ and vessels were least commonly affected.

The most common cause found was acute appendicitis which constituted nearly 26% followed by acute pancreatitis which formed 14%, followed by cholecystitis and urolithiasis which formed 10% each. (Figures 1-5)

The least common cases were of malrotation, mesenteric panniculitis, and ovarian torsion which constituted 1% each.

In our study of 120 cases, 29 cases (24. 16%) were equivocal on USG which needed CT and intraoperative surgical follow-up, for further workup. Among equivocal cases on USG, 11 cases (9%) of appendicitis needed CT for diagnosis. One case (1%) of bowel obstruction needed CT for evaluating the cause which turned out to

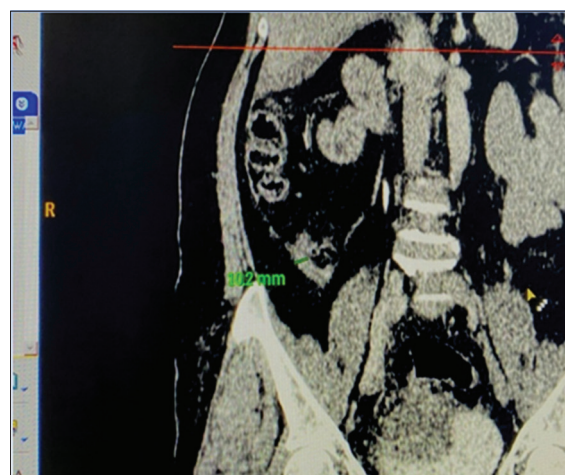


Figure 1: A patient presenting with right iliac fossa pain showing dilated appendix with mild fat stranding consistent with acute appendicitis (arrows)

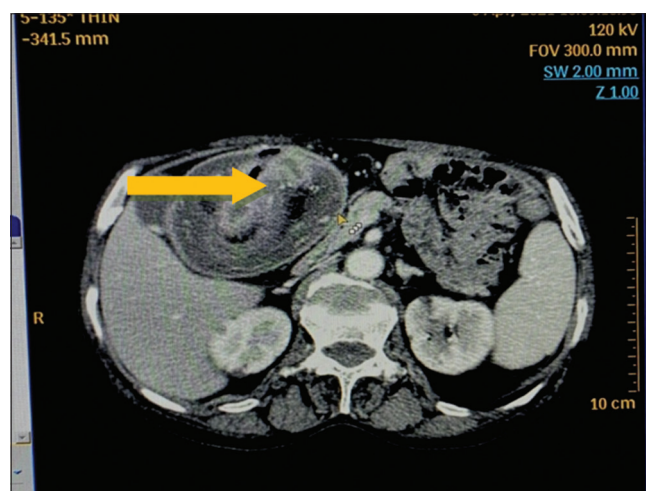


Figure 2: Axial contrast-enhanced CT (CECT) showing bowel within bowel appearance (target sign) with mesenteric fat (lead point) consistent with intussusception (arrows). Axial CECT showing whirlpool sign (arrows) consistent with malrotation

be stricture. Seven cases (6%) of pancreatitis, four cases (3%) of urolithiasis, two cases (2%) of peritonitis, two cases (1%) of pyelonephritis, and one case (1%) of gallbladder rupture and intussusception each needed CT for diagnosis. Two cases (2%) of SMA thrombosis and one case (1%) of mesenteric panniculitis were also noted.

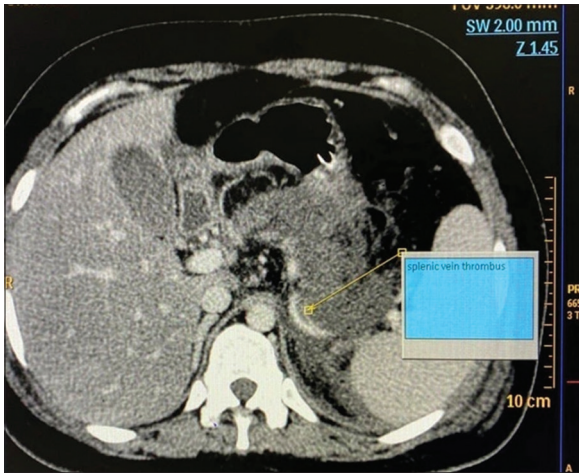


Figure 3: Necrotizing pancreatitis with splenic vein thrombus as complication

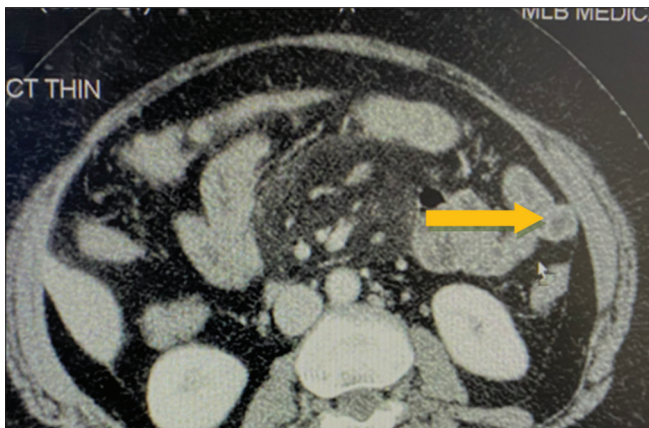


Figure 4: Focal area of increased fat stranding in the small bowel mesentery with fat ring sign consistent with mesenteric panniculitis (arrows)

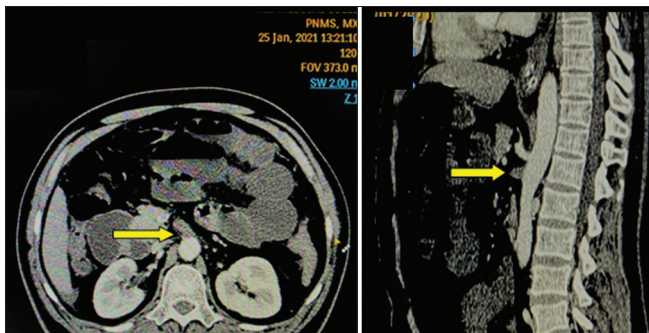


Figure 5: Axial and sagittal reformatted CECT showing intraluminal filling defect in the origin of superior mesenteric artery (SMA) suggesting SMA thrombosis (arrows)

DISCUSSION

Out of the 120 patients satisfying the inclusion criteria recruited into this study, the majority of cases found belongs to 3rd and 4th decades with mean age of 37.24 ± 14 which was similar to the study conducted by Ihezue et al., (1998)² who reported the 405 consecutive patients with acute abdomen with mean age of 29 years (3rd decade). In our study, majority 61% (73) of the study population were male which is consistent with the various similar studies conducted worldwide with male preponderance such as by Al-Mulhim (2006).³

Furthermore, the most common site of pain in our study were right lower (26%) followed by periumbilical (24%) and epigastric quadrant (19%) which are in agreement with study conducted by Asefa Z et al., (2000)⁴ who reported the most common site as lower abdomen (45%). Furthermore, in our study, USG was able to make probable diagnosis alone in 88 (74% cases), while rest 32 cases (26%) were equivocal/normal on USG.

Furthermore, the USG findings were consistent with the MDCT findings in 37 cases out of 50 (74%) in a study conducted by Singh et al., (2019)⁵ which is similar to our study.

In our study, 88 out of 120 cases (73.33%) were having abnormal USG and among that fluid, fat stranding, and nodes were the major findings constituting 72%, 49%, and 32%, respectively. Three cases (2%) were normal and 29 cases (24.16%) were equivocal which were correlated with CT findings which were similar to the study conducted by Balamurugan et al., (2020)⁶ who reported that USG was able to make final diagnosis consistent with CT in 89 cases out of 126 (70.6%).

Among the various CT findings, the majority of findings were in the form of fluid constituting 75% followed by fat stranding, nodes, calcifications, and air, 56%, 33%, 18%, and 17%, respectively. Furthermore, there was significant correlation between patient's age and presence of fat stranding in our study.

Age <40 year presenting with acute abdomen had more fat stranding with significant Pearson Chi-square coefficient.

In our study, bowel was the most commonly involved organ constituting 36% (43 out of 120) which was well correlating with the similar recent study conducted by the Balamurugan et al., (2020) who found 67 out of 126 cases (53.17%) with predominate bowel involvement. Furthermore, vessels were the least commonly involved organ in our study constituting two cases (2%) presenting with acute abdomen had CT findings confirming SMA thrombosis with bowel wall thickening and focal lack of enhancement which was similar

Table 1: Equivocal cases diagnosed only on CT

Cause	Frequency on USG	Percentage on USG	Frequency on CT	Percentage on CT	Difference in frequency	Difference in percentage
Appendicitis	20	17	31	26	+11	+9
Bowel obstruction	8	7	9	8	+1	+1
Pancreatitis	10	8	17	14	+7	+6
Cholecystitis/cholelithiasis choledocholithiasis/GB rupture	14	12	15	12	+1	0
Urolithiasis	8	7	12	10	+4	+3
Gut rotation	1	1	1	1	0	0
Pyelonephritis	3	3	5	4	+2	+1
Mesenteric lymphadenopathy	2	2	2	2	0	0
Mesenteric panniculitis	0	0	1	1	+1	+1
SMA thrombosis	0	0	2	2	+2	+2
Liver abscess	3	2	3	2	0	0
Splenic abscess	3	2	3	2	0	0
Peritonitis	5	4	7	6	+2	+2
Intussusception	1	1	2	2	+1	+1
Ovarian cyst/ovarian torsion/ pid/ruptured ectopic	10	8	10	8	0	0
Total	88	74	120	100	+32	+26

USG: Ultrasonography, CT: Computed tomography, SMA: Superior mesenteric artery

to the study conducted by the Moschetta et al., (2014)⁷ who stated that nearly 1% of cases present with acute ischemic bowel disease in the emergency department. These two cases went normal on USG in our study.

In our study group of 120 patients, we also enumerated the various causes of acute abdomen as mentioned in the Table 1. The most common etiology found was acute appendicitis forming 26%, which is consistent with most of the studies carried out internationally.

The second most common etiology was acute pancreatitis – 14%, followed by acute cholecystitis and urolithiasis 10% each.

The least common cases were malrotation, mesenteric panniculitis, and ovarian torsion which constituted 1% of the cases.

Among total 31 cases of acute appendicitis, majority (23) were male. The mean age was found to be 35.35 years which is in agreement with other studies. Furthermore, USG could diagnose only 20 cases but CT could diagnose additional 11 cases, which were not suspected in USG. Among 31 cases of acute appendicitis diagnosed on CT, 26 (84%) were uncomplicated cases, four cases (13%) belong to appendicular rupture, and rest one case (3%) was of mucocoele of appendix/appendicitis.

In our study, 31 patients had CT findings of acute appendicitis and related conditions. Five out of 31 were discordant with intraoperative surgical findings and were finally diagnosed to be appendicular abscess and confirmed by surgical correlation.

Hence, the sensitivity and positive predictable value of MDCT were 100% and 84.18%, respectively. This is consistent with study conducted by Rao et al., (1997)⁸ which shows 91–100% sensitivity for CT in the diagnosis of appendicitis.

About 17 out of 120 cases of our study had CT findings confirming acute pancreatitis with sensitivity of approximately 100%. USG had missed seven cases and it could diagnose only ten cases. Comparable results are shown by Begeer et al., (1997)⁹ and Balthazar et al., (2003).¹⁰ Acute pancreatitis and CT findings very well correlate with severity index in the study conducted by them. It accurately detects the complications such as pseudo aneurysm of splenic artery and portomesenteric venous occlusion.

In our study, 12 out of 120 cases had CT findings confirming urolithiasis with sensitivity of approximately 100%. The above findings were in comparison to the data arrived by Boulay et al., (2015)¹¹, in which sensitivity was 100%.

Furthermore, in our study, majority of cases were male (12 out of 120) with peak age in 4th decade and majority of cases were involving mid and distal ureter followed by renal calyces which were similar to the study conducted by Reddy and Reddy (2010)¹² who did prospective study for patients with loin pain, who are clinically suspected for urinary stone disease. It was found that maximum patients belonged to the age group of 41–50 years followed by 31–40 years and males were much more than females and maximum patients presented with distal ureteric calculi, that is, 40% followed by renal calculi (18.8%).

In urolithiasis, MDCT helps in detecting subtle calculi by the thin slice collimation and by the presence of focal

periurethral stranding and other secondary CT signs of ureteric calculi.

In our study, 13 out of 120 cases had CT findings confirming acute cholecystitis with cholelithiasis with sensitivity of almost 98–100% which is comparable to other international studies. Out of 13 cases, 63% cases belong to females of 3rd and 4th decade which is comparable to the study findings of Chaudhry et al.¹³ The female preponderance is attributable to the higher estrogen level, especially during their reproductive age group. Although USG is first line investigation, CT can be used as adjunct when findings are equivocal on USG or when there are complications of cholecystitis such as emphysematous type with rupture and associated duodenitis and fistula formation.

The CT appearance of gallstones can vary. Calcified gallstones are readily detected at CT, but non-calcified gallstones are often difficult to visualize, because they are isoattenuating to the surrounding bile.

In our study, nine out of 120 cases were diagnosed to have bowel obstruction.

MDCT picked the etiology in additional one case as stricture which was equivocal on USG. The sensitivity and positive predictable value of MDCT were around 88.88% which is in agreement with study conducted by Mallo et al., (2005)¹⁴ in which sensitivity of MDCT in diagnosis of bowel obstruction is 81–100% and specificity 68–100%.

In our study, six out of seven cases of peritonitis were confirmed to have perforation by MDCT. One cases of perforation in CT findings and surgical findings were not correlating, the reason being sealed perforations after a time period, it could not be detected.

The accuracy rate for perforation in our study was 85.71% which was comparable to the study done by Sung Hwan Kim et al., (2017)¹⁵ who gave an accuracy of 82–90% for predicting site of perforation by CT. Because, in our study, the accuracy rate was less because one case was presented very late to us after a week of diagnostic dilemma.

We also compared the role of USG and MDCT in evaluation of patients with acute abdomen in 120 patients. USG diagnosis was correlating with MDCT diagnosis in 85 out of 120 cases (70.83%).

Furthermore, the pre-CT diagnosis was compared with post-CT diagnosis and it was found that CT findings changed the initial diagnosis in 32 cases (26%) which were equivocal/normal on USG, which was similar to the study

conducted by Singh et al., (2019)⁵ who reported change of USG diagnosis in 14 cases out of 50 (28%) when compared with MDCT.

The post-CT diagnosis in our study was consistent with the final clinical diagnosis in 111 out of 120 cases (92.5%) which are similar to study conducted by Chin et al., (2012)¹⁶ who reported the accuracy rate of 87.5%.

The CT findings were discordant with intraoperative findings in nine cases: Under estimating five cases of appendicular abscess and misinterpreting multiple sealed perforation sites as case of perforation peritonitis and misinterpreting 1 case of appendicular perforation as ascending colon perforation. Furthermore, in our study, two cases of GB rupture could not be followed up.

Hence, the sensitivity, accuracy rate, and positive predictive value of MDCT for diagnosing cases in our study were 95.83%, 94.16%, and 98.33%, respectively, which were comparable to the study results of Mackersie et al., (2005)¹⁷ who reported sensitivity, specificity, and accuracy rate of MDCT as 96%, 95%, and 95.6%, respectively.

Similar, study was also conducted by Weir-McCall et al., (2011) who compared pre-operative CT findings with operative findings in 97 patients with accuracy rate varied from 78–93%.

Limitations of the study

- As most of the patients are taken up for emergency laparotomy after USG examination, the number of patients who come for further CT examination are less in number.
- Cost and restriction in pregnant patients for radiation exposure is also one of the limitations.

CONCLUSION

The results obtained in this prospective study were comparable to pioneer studies conducted worldwide. However, the major limitation was limited sample size, cost of CT, and majority of patients went to urgent laparotomy after USG. MDCT is the most rapid, specific, time efficient, objective, and informative imaging technique. MDCT is a widely accepted primary investigation of choice in patients coming with intense abdominal pain with the exception of acute cholecystitis, in which USG is highly sensitive in diagnosis.

Thus, to conclude, MDCT has high sensitivity in detecting various pathologies in cases of inconclusive situations on USG, in symptomatic patients with negative USG scans and in patients with suboptimal scan. Despite the small risk of radiation and increased cost, prompt use of MDCT is

recommended when the clinical examination is in suspicion, and investigations, such as plain radiograph of abdomen and USG examinations, are equivocal or inconclusive.

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Authors' Contributions:

RS, PK- Concept and design of the study, prepared first draft of manuscript; Interpreted the results; and reviewed the literature and manuscript preparation; Concept, coordination, preparation of manuscript, and revision of the manuscript.

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