Original Article

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Radiology Section

Diagnostic Accuracy of Multi-detector Computed Tomography in the Evaluation of Non-traumatic Acute Abdominal and Pelvic Emergencies: A Cross-sectional Study

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ABSTRACT

Introduction: Acute abdomen can sometimes be life-threatening and requires an exact diagnosis and appropriate management to avoid mortality among patients. Multi-detector Computed Tomography (MDCT) provides a specific diagnosis and the whole picture of pathology, especially in patients with inconclusive diagnoses.

Aim: To evaluate the accuracy of MDCT in diagnosing non-traumatic acute abdominal and pelvic emergencies.

Materials and Methods: A cross-sectional study was conducted on 100 patients who presented with acute abdomen and had inconclusive diagnoses based on clinical examination, laboratory investigations, and other imaging modalities. MDCT was performed with a specific protocol depending on the clinical diagnosis. The MDCT results were compared with intraoperative findings, clinical recovery, and Histopathological Examinations (HPE). Data was entered into a Microsoft Excel spreadsheet and analysed using Statistical Package for Social Sciences (SPSS) version 20.0.

Results: The MDCT diagnosis was concordant in 95% of patients and discordant in 5% of patients. Acute appendicitis was the most common cause of acute abdomen (20%). Overall sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of MDCT in diagnosing the aetiology of acute abdomen were 96.49% (CI 87.89% to 99.57%), 97.67% (CI 87.71% to 99.94%), 98.21% (CI 90.45% to 99.95%), 95.45% (CI 84.53% to 99.44%), and 97%, respectively.

Conclusion: Since the clinical findings overlap in patients with acute abdomen, making an accurate clinical diagnosis is challenging. In these cases, MDCT provides a diagnosis with high accuracy and specificity in a short duration of time; hence, MDCT should be performed in acute abdominal emergencies for appropriate patient management.

Keywords: Acute abdomen, Imaging modalities, Ultrasonography

INTRODUCTION

'Acute abdomen' means that the patient complains of an acute attack of abdominal pain that may occur suddenly or gradually over a period of several hours. It presents as a symptom complex that suggests a disease that possibly threatens life and demands an immediate or urgent diagnosis for early treatment [1].

The causes of acute abdominal pain range from benign self-limiting to life-threatening disorders. The common causes are acute appendicitis, diverticulitis, cholecystitis, acute pancreatitis, renal calculi, bowel obstruction, and perforated viscera. Other important but less frequent causes include bowel ischaemia, ruptured abdominal aortic aneurysm, aortic dissection, intra-abdominal haemorrhage, etc. [2].

A prompt and accurate diagnosis is necessary to enable timely treatment and to reduce morbidity and mortality. However, a confident diagnosis can be difficult as medical history, physical examination, and laboratory tests are usually non-specific. The initial imaging examination performed in these patients is abdominal radiography as it is widely available and may help in assessing intestinal obstruction, hollow viscus perforation, and renal calculi. The overall diagnostic accuracy of x-rays in all cases of non-traumatic acute abdomen has been reported up to 40% [3].

Ultrasonography (USG) is another imaging modality used in acute abdomen and is widely available, cheap, and has the advantage of real-time dynamic evaluation, especially to look for peristalsis and to examine the point of maximum tenderness. It is useful in acute cholecystitis, cholelithiasis, renal calculi, acute appendicitis, and in some cases of pancreatitis. Pelvic pathologies are also better picked up on USG. The absence of radiation makes it the modality of choice in evaluating pregnant females and children. However, sonography has an overall accuracy of 52% and specificity of 78.4% in cases of nontraumatic acute abdomen [3,4].

The role of these basic radiological investigations is limited by various factors. The major limiting factor is the two-dimensional nature of radiographs. In USG, the limiting factors are the inability of the patient to co-operate for the study as they are sick and in severe pain, thick body habitus of the patient, excessive bowel gas, etc. [5]. Thus, most of the time these modalities do not provide a specific diagnosis. In such patients with an inconclusive diagnosis, MDCT is a widely accepted investigation as it provides a specific diagnosis in a short duration of time, thus helping in deciding the treatment of patients [6]. It also gives us clear data for another possible diagnosis if the working clinical diagnosis is incorrect and thus helps in planning treatment for patients, thereby reducing the number of unnecessary laparotomies and hence reducing treatment cost, pain, and surgical morbidity of patients.

Various studies have evaluated the diagnostic accuracy of MDCT and concluded that clinical examination and laboratory parameters show poor sensitivity and specificity and hence cannot be depended upon. However, CT has good sensitivity and specificity and is an ideal tool in the evaluation of the acute abdomen [7,8]. Furthermore, early CT in patients with non-traumatic acute abdomen helps in arriving at an accurate diagnosis and planning appropriate treatment [9]. The present study aimed to evaluate the diagnostic accuracy of

MDCT in acute abdominal and pelvic emergencies as compared with operative/HPE findings or clinical follow-up. This study will enhance our knowledge as to which pathologies should be kept in mind while doing CT in cases of acute abdomen in emergencies.

MATERIALS AND METHODS

This was a time-bound cross-sectional study conducted in the Department of Radio-diagnosis at Indira Gandhi Medical College, Shimla, Himachal Pradesh, India from June 2019 to June 2020 on 100 patients presenting with acute abdomen and meeting the inclusion and exclusion criteria as described below. The research procedure was carried out following the approved standards of the Institutional Ethics Committee, and informed consent was obtained from all patients.

Inclusion criteria: Patients with acute abdomen and inconclusive diagnosis on clinical examination, laboratory investigations, X-ray abdomen (Erect and Supine), and Ultrasonography (USG) abdomen.

Exclusion criteria: Patients with confirmed diagnoses on other modalities, deranged renal function tests, a previous history of serious allergic reactions or CT contrast allergy, and pregnant patients.

Procedure

A detailed relevant history was taken followed by clinical examination, necessary laboratory investigations, plain radiography abdomen {Supine/Erect Antero-posterior (AP) view}, and USG. When the diagnosis remained inconclusive with these modalities, MDCT was performed on a 64-slice MDCT scanner, LightSpeed VCT Xte GE medical systems.

The MDCT scan was conducted from the diaphragm to the greater trochanter of the femur. The MDCT protocol was tailored according to the clinical diagnosis. The abdominal MDCT protocol for adult patients was as follows: 120kVp, mAs modulation with a range of 60-450 mAs, slice thickness 5 mm, interval 5 mm, reconstruction interval 0.625 mm, and pitch-0.984. The CT parameters were adjusted based on the age and weight of the patients.

All patients who underwent intravenous Contrast Enhanced CT (CECT) abdomen received 1.5 mL/kg body weight of non-ionic contrast (300 mg iodine/ml) at a rate of 2.5 mL/second (for abdominal angiography-4 mL/second), followed by 20 mL of saline fluid at a rate of 2.5 mL/second. The MDCT findings were compared with intraoperative findings, HPEs, or clinical improvement of the patients. In patients managed conservatively, the MDCT diagnosis was considered concordant with the final diagnosis if there was a good clinical response to medical treatment, while the MDCT diagnosis was considered discordant if there was no clinical improvement in the patients.

STATISTICAL ANALYSIS

The data was collected, cleaned, and entered into a Microsoft excel spreadsheet, transferred to Epi Info (Latest version) software, and analysed using SPSS version 20.0. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of MDCT were calculated.

RESULTS

There were 100 patients included in the study. The mean age (years) of the study subjects was 44.93 ± 22.6 with a median (25^{th}-75^{th} percentile) of 46.5 (28-62). Fifty-four (54%) were males, and 46 (46%) were females. X-ray abdomen was performed on 96 patients, out of which 71 were normal, and 25 patients had positive findings on X-ray [Table/Fig-1]. X-ray was not performed on four patients as it was not advised by the treating physician since the patients were extremely sick and directly referred for CT. The overall sensitivity of X-rays in acute abdomen was 26.04%. Ultrasound was done in all 100 patients; in 82 (82%) patients, there were findings related to acute abdomen, and in 18 (18%), USG was normal.

X-ray positive findings	Frequency	Percentage
Urolithiasis	3	12.00%
Air under diaphragm	2	8.00%
Dilated gut loops with air fluid levels	20	80.00%
Total	25	100.00%

[Table/Fig-1]: Distribution of X-ray positive findings in study subjects.

On MDCT, bowel and appendix-related causes were more common [Table/Fig-2-4], followed by acute pancreatitis and urolithiasis. One patient had normal CT findings and showed improvement with conservative management. Out of 100 patients, 57 (57%) were managed surgically, and 43 (43%) conservatively. Histopathology reports were available for all patients who had undergone surgery, which showed that four patients had malignancies as the cause of intestinal obstruction. On histopathology, these were non- Hodgkin's lymphoma of the jejunum, adenocarcinoma of the rectum, well-differentiated adenocarcinoma of the ascending colon, and mucinous adenocarcinoma of the sigmoid colon.

Specific organ related CT diagnosis	Frequency	Percentage
Appendix	20	20%
Pancreas	10	10%
Urinary system	10	10%
Bowel	40	40%
Pelvis	06	6%
Vascular	05	5%
Gall Bladder (GB)	03	3%
Others	05	5%
Normal study	01	1%
Total	100	100%

[Table/Fig-2]: Distribution of Multi-detector Computed Tomography (MDCT) findings in study subjects.

Causes of intestinal obstruction	Pathology	Frequency	Percentage
Benign causes	Stricture	3	3%
	Adhesions	2	2%
	Ileal duplication cyst	1	1%
	Strangulated inguinal hernia	1	1%
	Inflammatory bowel thickening	1	1%
	Gossypiboma	1	1%
	Paraumbilical hernia	1	1%
	Mesenteric lymphadenopathy	1	1%
Malignant causes	Carcinoma rectum	2	2%
	Carcinoma sigmoid colon	1	1%
	Carcinoma ascending colon	1	1%
Total		15	15%

[Table/Fig-3]: Causes of intestinal obstruction on MDCT.

S. no.	Site of perforation	Frequency	Percentage
1	Duodenal	2	2%
2	Ileal	2	2%
3	Pre-pyloric	1	1%
4	Jejunal	1	1%
5	Gastro-jejunostomy site	1	1%
Total		7	7%

[Table/Fig-4]: Site of hollow viscus perforation diagnosed on MDCT.

In the first discordant case, the initial diagnosis based on the MDCT was dilated ileal loops with mesenteric lymphadenopathy, however, on surgery it was proved to be Meckel's diverticulum.

The second discordant case involved a jejunal perforation identified on MDCT, however, on surgery, it was found to be a jejunal mass along with perforation, ultimately diagnosed as jejunal lymphoma on histopathological examination. This patient exhibited thickening of the proximal jejunum measuring 9.40 cm in length and 13.8 mm in maximum width, accompanied by pneumo-peritoneum and ascites.

In emergency situations, bowel preparation for a CT scan is not typically performed, making it challenging to differentiate between gut thickening and collapsed gut loops. Additionally, since the patient presented to the Emergency Department with acute pain, while malignancy typically presents with dull pain, the possibility of Lymphoma was not considered in the emergency setting and therefore missed.

Among the two discordant cases related to Infective bowel disease, one case initially diagnosed as abdominal tuberculosis on MDCT was started on Category-II anti-tubercular treatment. However, the patient did not respond to the treatment and eventually succumbed to the illness. As a result, it was assumed that the diagnosis of abdominal tuberculosis was incorrect, given the lack of response to treatment and the patient's unfortunate outcome.

The second discordant case was diagnosed as infective colitis on CT, revealing thickening of the wall of the terminal ileum, caecum, ascending colon, and transverse colon. The bowel wall exhibited patchy mucosal enhancement, mural oedema, and enhancement of the serosa on the portal venous phase CT (only portal venous phase was conducted due to clinical suspicion of peritonitis rather than bowel ischaemia). Additionally, enhancement of the peritoneum was observed. Despite the absence of pneumo-peritoneum during the CT examination, the patient did not show clinical improvement, leading to surgery being performed the following day, eight hours after presentation. The surgical findings included gangrene of the terminal ileum, caecum, ascending colon, and part of the transverse colon, along with perforation of the caecum. Pus was aspirated from the abdominal cavity, and an ileo-colic anastomosis was performed. While some findings were identified on CT, gangrene was not detected, possibly due to the delay of eight hours between CT and surgery, allowing for the development of gangrene and perforation during that time.

The final discordant case involved an undescended testis in the right inguinal canal, which was later found to be an undescended testis with torsion during surgery. This patient presented with a history of pain in the Right Iliac Fossa (RIF). On CT, minimal fluid was observed in the pelvis, likely reactionary. The right testis was un-descended and located in the inguinal canal, showing enlargement and hypo-enhancement, but with eccentric enhancement of testicular vessels on CT (only portal venous phase was performed). Given the patient's pain in RIF, a CT scan was recommended to rule out any other pathology at that site. As no other pathology was identified apart from the testicular tissue on CT, surgery was performed on the same day, revealing testicular torsion in the undescended testis. This highlights that testicular pathologies are better detected using USG, and CT should not be routinely recommended for testicular torsion.

Cholelithiasis with associated complications was the cause of acute abdomen in three patients (acute pancreatitis, acute cholecystitis, and Gallbladder (GB) perforation). The CT detected cholelithiasis in only one case. In one case, GB perforation was not detected on USG, and a diagnosis of cholelithiasis with acute cholecystitis was made. The patient was managed conservatively. However, the patient did not respond to treatment, deteriorated, and developed peritonitis. In this patient, MDCT showed GB perforation with peritonitis. The patient underwent surgery, and the intra-operative findings were concordant with MDCT findings. In the other two cases of cholelithiasis with acute pancreatitis and acute cholecystitis, conservative management was performed, and the patients improved [Table/Fig-5].

The overall sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated [Table/Fig-6].

DISCUSSION

The spectrum of aetiologies of acute abdominal pain may range from those that are benign and self-limiting to those that require immediate surgical management. MDCT is the mainstay imaging modality in patients with acute abdominal pain due to its multiplanar reconstruction, short scanning time, decreased motion artifacts, dose adjustment, and dose reduction capabilities.

Specific organ	Diagnosis on MDCT	MDCT diagnosis frequency	Final diagnosis frequency	Conservative management (n=43)	Surgical management (n=57)	Concordance/ discordance
Appendix	Appendicitis, Perforation	20	20	0 (0%)	20 (20%)	Concordant
Pancreas	Pancreatitis	10	10	10 (23.26%)	0 (0%)	Concordant
Urinary system	Urolithiasis	10	10	8 (18.60%)	2 (3.51%)	Concordant
Bowel related	Benign obstruction	11	10	4 (9.30%)	6 (10.53%)	1 Discordant
	Malignant obstruction	04	05	0 (0%)	5 (8.77%)	Concordant
	Perforation	07	06	0 (0%)	6 (10.53%)	1 Discordant
	Infective	06	05	4 (9.30%)	1 (1.75%)	2 Discordant
	Inflammatory	01	01	1 (2.33%)	0 (0%)	Concordant
	Ischemic	03	04	1 (2.33%)	3 (5.26%)	Concordant
	Intussusception	02	02	0 (0%)	2 (3.51%)	Concordant
	Sigmoid volvulus	03	03	0 (0%)	3 (5.26%)	Concordant
	Midgut volvulus	01	01	1 (2.33%)	0 (0%)	Concordant
	Meckel's diverticulum	01	02	0 (0%)	2 (3.51%)	Concordant
	Gastric emphysema	01	01	1 (2.33%)	0 (0%)	Concordant
Pelvic	Perforation uterus, ectopic, etc.,	06	06	4 (9.32%)	2 (3.51%)	Concordant
Vascular aetiology	Aneurysm, dissection, etc.,	05	05	3 (6.9%)	2 (3.51%)	Concordant
Gall Bladder (GB)	Cholecystitis, perforation	03	03	2 (4.66%)	1 (1.75%)	Concordant
Others	Testicular, etc	05	05	4 (9.33%)	1 (1.75%)	1 Discordant
Normal	Normal study	01	01	1 (2.33%)	0 (0%)	Concordant
Total		100	100	43	57	5 Discordant

[Table/Fig-5]: Comparison of MDCT diagnosis with final diagnosis along with management technique and concordance/discordance.

Sensitivity	96.49% (CI 87.89% to 99.57%)
Specificity	97.67% (CI 87.71% to 99.94%)
Positive predictive value	98.21% (CI 90.45 % to 99.95%)
Negative predictive value	95.45% (CI 84.53% to 99.44%)
Diagnostic accuracy	97%

[Table/Fig-6]: The overall statistical values of MDCT in diagnosis of acute abdominal and pelvic pathologies as compared with final diagnosis.

Appendix-related pathologies are one of the common causes of acute abdominal emergencies. Acute appendicitis was correctly diagnosed in all eight patients on MDCT based on the findings of an enlarged appendix (>6 mm caliber), adjacent fat stranding, and appendicolith [10]. Out of these eight patients, five had probe tenderness in the RIF, two had normal findings, and in one case, a diagnosis of thickened gut loops in the RIF with an inflammatory cause was made on USG. There were two cases of retro-caecal appendicitis and a case of an appendix in a sub-hepatic location [Table/Fig-7], which was clinically diagnosed as acute cholecystitis. After performing MDCT, the entire management of the patient changed. USG of this patient showed a normal GB. The appendix was not visualised due to overlying bowel shadows. The rest of the organs were normal. Hence, MDCT should be performed in patients with atypical abdominal pain and an inconclusive diagnosis on USG.

[Table/Fig-7]: Sub-hepatic appendicitis: Coronal reformatted portal venous phase MDCT image showing inflamed retrocaecal appendix coursing in subhepatic location (arrow).

In five patients on USG, no definite cause of collection was ascertained, while three had an appendicular lump, three had dilated small bowel loops, and one case was diagnosed as mesenteric lymphadenopathy with minimal ascites. On MDCT, all these 12 cases were found to have a perforated appendix with free fluid, some showing extra-luminal air, a defect in the appendiceal wall, and abscess. Thus, MDCT changed the final diagnosis to appendicular perforation in these 12 cases, which were diagnosed only as a collection on USG.

The sensitivity and specificity of MDCT in appendix-related pathologies were 100%, consistent with studies conducted by Viyannan M et al., and Shebrya NH et al., which showed a sensitivity of 100% and a positive predictive value of 93.75%, and a sensitivity of 95% and specificity of 100%, respectively [4,8]. The diagnosis of appendicitis is usually made based on history, physical examination, laboratory findings, and USG. However, sites that are not accessible on USG, such as the retro-caecal and sub-hepatic locations, and complications like perforation, abscess, and mass formation, are better detected on MDCT. Early diagnosis and differentiation of acute appendicitis and perforated appendix from appendicular lump and abscess are crucial because the management of the patient changes accordingly. In appendicular abscess, aspiration or pigtail drainage is performed, and in appendicular lump, interval appendicectomy is carried out after six weeks (Ochsner-Sherran regimen) [11].

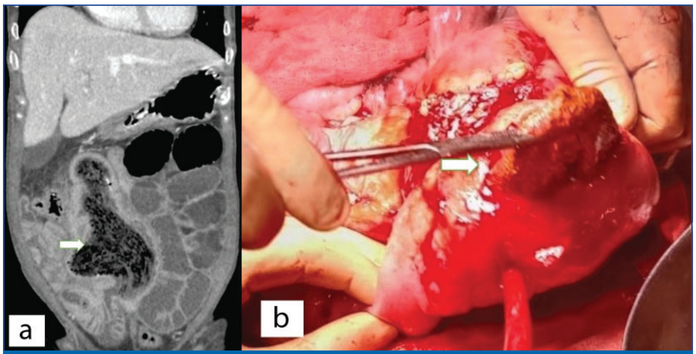
Hollow viscus perforation was diagnosed in all cases on MDCT based on the findings of extraluminal air and fluid (the "falciform ligament sign" and "ligamentum teres sign," indicating free air crossing the midline and accentuating the falciform ligament, and free air confined in the intra-hepatic fissure for the ligament teres, respectively) [12,13]. However, in one case, there was an associated jejunal mass (non Hodgkin's lymphoma) that was missed on MDCT. In this particular case, since the patient presented with an acute abdomen, which is unusual for malignant pathology, and MDCT only showed bowel wall thickening with perforation, the bowel wall thickening was assumed to be due to inflammation. The present study demonstrated a sensitivity of 100% and a specificity of 98.94% for hollow viscus perforation. A study conducted by A. Sravan Krishna Reddy et al., showed 100% sensitivity and specificity of MDCT for hollow viscus perforation [14]. MDCT should be performed in all suspected cases of hollow viscus perforation as it can detect even minimal amounts of free air and pin-point the site of perforation. Consequently, MDCT reduces the surgeon's burden of searching for the perforation site during surgery, thereby reducing morbidity.

In another case with a clinical suspicion of duodenal perforation, MDCT revealed evidence of gastric emphysema [Table/Fig-8], with no signs of perforation or pneumo-peritoneum. The non diabetic patient had Chronic Obstructive Pulmonary Disease (COPD) and experienced repeated vomiting episodes. The chest scan showed emphysematous changes. In this case, gastric emphysema may have been caused by the dissection of air from the chest into the stomach wall initiated by vomiting. The patient was conservatively managed by the Pulmonary Medicine Department, received antibiotics, intravenous fluids, nebulisation, intravenous steroids, proton pump inhibitors, anti-emetics, and oxygen. After a repeat MDCT two days later, the gastric emphysema had significantly reduced, and the patient had shown clinical improvement. MDCT altered the initial clinical diagnosis of duodenal perforation, thus avoiding surgical intervention.

[Table/Fig-8]: Gastric emphysema: Axial portal venous phase MDCT abdomen image showing air in the gastric wall (arrow) with ascites.

In a post-hysterectomy patient, gossypiboma (with a spongiform appearance and gas bubbles) that had migrated intra-luminally into one of the ileal loops, causing proximal gut dilatation, was diagnosed on MDCT [Table/Fig-9a,b].

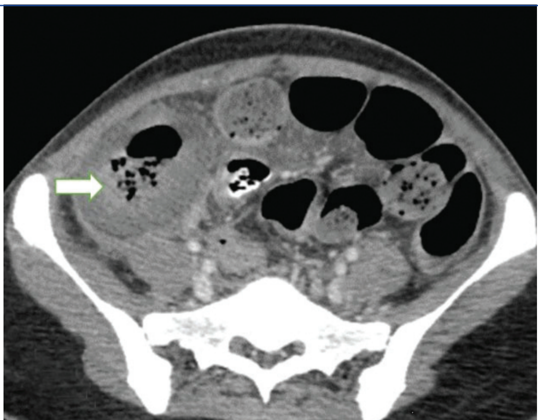
In another case, an ileal duplication cyst with proximal gut dilatation was diagnosed on MDCT in a one-year-old child. The sensitivity, specificity, and diagnostic accuracy of CT in diagnosing benign causes of obstruction were 80%, 100%, and 99.00%, respectively, while for malignant causes, they were 100%, 98.89%, and 99.00%, respectively. This aligns with a study conducted by Elsayed EM et al., which reported a sensitivity, specificity, and diagnostic accuracy of 100% [15]. MDCT offers an additional advantage of identifying the cause, site, and level of obstruction.



[Table/Fig-9]: Gossypiboma: (a) Coronal portal venous phase MDCT image showing an ill-defined heterogenous area with thick enhancing wall containing mottled air foci (arrow) with dilated gut loops proximally; (b) Intraoperative image showing gauze piece extraction from jejunum (arrow).

Among the cases of ischemic bowel disease diagnosed on MDCT, one case revealed a thrombus in the Superior Mesenteric Artery (SMA) and coeliac axis, along with thinned-out, hypo-enhancing walls of jejunal loops and pneumo-peritoneum. The patient underwent surgery with resection of the unhealthy, perforated, and necrosed jejunal loops. In another case, a thrombus was found in the Superior Mesenteric Vein (SMV), and oedematous gut loops exhibited abnormal bowel enhancement (displaying a "Halo sign" or "target sign" due to mural stratification into layers), along with mesenteric stranding and ascites [16]. During surgery, evidence of venous mesenteric ischaemia with gangrenous distal jejunum was observed, leading to resection of the un-healthy distal jejunum with jejuno-ileal anastomosis. Both patients received heparinisation for SMA and SMV thrombus, respectively, and recovered. In the third case of ischemic bowel disease, extensive pneumatosis intestinalis (air in the bowel wall) was present, along with gastric emphysema, leading to a diagnosis of non-occlusive mesenteric ischaemia due to the patient being in septicaemia. The sensitivity and specificity of MDCT in diagnosing ischemic bowel disease were 75% and 100%, respectively, consistent with a study by Magnini M et al., which reported sensitivity ranging from 67% to 100% and specificity ranging from 83% to 100% [17]. MDCT is the preferred first-line imaging modality for diagnosing mesenteric ischaemia, enabling classification into occlusive (arterial, venous) and non-occlusive types [18]. It also evaluates severity, aiding clinicians in appropriate management, guiding interventionists in patient selection, and planning for endovascular management in patients with acute mesenteric ischaemia.

Among the cases of infective bowel disease, three cases diagnosed as abdominal tuberculosis on MDCT (based on findings of ileo-caecal wall thickening, ascites, and necrotic lymph nodes) responded well to treatment. However, the fourth case, also diagnosed as abdominal tuberculosis on MDCT and started empirically on Anti-tubercularTreatment (ATT), did not show improvement and unfortunately passed away after two months. In a patient with infective colitis, elevated titers of typhi 'O' and 'H' antigens led to a diagnosis of typhoid colitis [Table/Fig-10], and the patient responded well to antibiotic therapy and ultimately recovered.



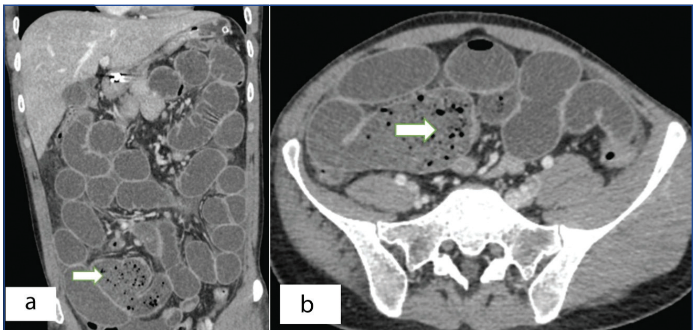
[Table/Fig-10]: Infective colitis: Axial reformatted portal venous phase image showing hypo-enhancing oedematous wall of caecum (arrow) with ascites.

In another case of typhlitis diagnosed on MDCT, a peripheral blood smear revealed features of Acute Myeloid Leukemia (AML) with a neutrophil count of zero, resulting in a diagnosis of neutropenic typhlitis. Additionally, a case of infective colitis diagnosed on MDCT was found to involve gangrenous terminal ileum, caecum, ascending colon, a perforated appendix, and pus collection in the pelvis during surgery. The sensitivity of MDCT in diagnosing infective bowel disease was 100%, with a specificity of 98.95%, consistent with a study conducted by Sravan Krishna Reddy A et al., which reported sensitivity and specificity of 100% [14]. Therefore, MDCT can aid in diagnosing infective bowel disease, but additional supportive investigations may be necessary for collaboration and confirmation before initiating treatment.

Among cases of intussusception (demonstrating a "bowel within a bowel" appearance), one case involved jejuno-jejunal intussusception with gangrene, while another case had ileo-colic intussusception, both with polyps as the lead point. The sensitivity and specificity of MDCT in diagnosing intussusception were both found to be 100%, consistent with a study by Ko HS et al., which also reported a sensitivity of 100%. However, present sample size was smaller [19]. Abougabal AM et al., conducted a study on the role of MDCT in diagnosing secondary intussusception in children in 2014, involving 12 cases, and found the exact diagnosis and identified the lead point in all cases [20]. In the present study, polyps as the lead point were not detected in either patient, as they exhibited attenuation similar to the collapsed intussuscepted bowel.

Patients with clinical features of intestinal obstruction and volvulus on MDCT showed signs of closed-loop obstruction, such as the "double beak sign" due to tapering bowel loops at the point of obstruction, twisting of the mesentery and vessels, and a reversed relation of the Superior Mesenteric Vein (SMV) and Superior Mesenteric Artery (SMA) in one patient [21]. The authors observed 100% sensitivity and specificity in diagnosing volvulus, which is consistent with a study by Sravan Krishna Reddy A et al., [14].

Among the cases of Meckel's diverticulum, there was a clinical suspicion of appendicitis in one case, while no definite clinical diagnosis was made in another case. One case was correctly diagnosed and exhibited a "small bowel feces sign" (presence of feculent material mixed with gas bubbles in the small bowel) [Table/Fig-11]. In another case, a diagnosis of mesenteric lymphadenopathy with acute intestinal obstruction was made on MDCT. However, the presence of dilated ileal loops and absence of classical findings of Meckel's diverticulum, such as a blind-ending dilated loop in the anti-mesenteric border, led to a missed diagnosis on MDCT. The sensitivity was 50%, possibly due to less experience in diagnosing Meckel's diverticulum. In a prospective study by Priola AM et al., involving 185 patients, only three cases of Meckel's diverticulum were identified, which were consistent with intraoperative findings, with an overall sensitivity of 87.3% [22].



[Table/Fig-11]: Meckel's diverticulum with dilated small bowel loops: (a) Coronal portal venous phase MDCT image depicting blind ending bowel loop arising from anti mesenteric border of ileal loop (arrow); (b) Axial reformatted image showing feces sign in Meckel's diverticulum (arrow).

Among the ten cases of acute pancreatitis, six were diagnosed as acute necrotizing pancreatitis and four as acute interstitial oedematous pancreatitis without associated vascular complications. Morphologically, two types of pancreatitis are considered: interstitial pancreatitis (without tissue necrosis) and necrotizing pancreatitis (with tissue necrosis) [23]. In nine cases, the diagnosis was confirmed by elevated levels of pancreatic enzymes (Serum Amylase and Serum Lipase) and the clinical course of the patients. In one case, the levels of Serum Amylase and Serum Lipase were within normal limits; however, the patient improved with conservative treatment for acute pancreatitis. The sensitivity of MDCT in diagnosing acute pancreatitis was 100%, consistent with studies by Viyannan M et al., and Rafiq S et al., which also reported a sensitivity of 100% [8,24]. While pancreatic enzyme levels and ultrasound are helpful in diagnosing acute pancreatitis, the advantages of MDCT include visualisation of the pancreas in obese patients and those with excessive bowel shadows. Additionally, MDCT allows for the assessment of complications of pancreatitis and severity, aiding in predicting the prognosis of the disease.

Non-Contrast CT (NCCT) of the Kidney-Ureter-Bladder (KUB) is performed in patients with clinical suspicion of urolithiasis. In two cases where acute appendicitis was clinically diagnosed, MDCT identified ureteric calculi as the cause of pain in these patients. Out of the ten cases of urolithiasis, two underwent Double J stenting-one for a left mid-ureteric calculus and one for a right lower ureteric calculus, while the rest were managed conservatively. The sensitivity and specificity of NCCT KUB in diagnosing urolithiasis were both 100%, consistent with a study by Rahul Kumar Reddy G and Swetha Reddy A, which reported a sensitivity of 91% [25]. X-ray KUB requires proper bowel preparation, which is often not feasible in emergency situations, and radiolucent calculi may be missed on X-ray KUB. Ultrasound has limitations in detecting mid and lower ureter calculi, possibly due to bowel shadows and pelvic bone interference. NCCT KUB is considered the best imaging modality for diagnosing urolithiasis as it accurately depicts the level of the calculus through multiplanar reconstruction, assesses the density of the calculus, and can identify associated complications like obstruction and infection. It can also provide alternative diagnoses such as pelvi-ureteric junction narrowing or developmental anomalies. Therefore, MDCT plays a crucial role in planning patient management.

MDCT can also be utilised in gallbladder-related emergencies. The sensitivity and specificity of MDCT in diagnosing acute cholecystitis and gallbladder perforation were both 100%, aligning with a study by Sravan Krishna Reddy A et al., which reported a sensitivity of 81.8% and specificity of 100% for acute cholecystitis [14]. While MDCT is not the preferred modality for diagnosing gallstones, it can accurately depict the site of gallbladder perforation and cholecystitis.

Among the pelvic pathologies, MDCT depicted the exact site of a rent in the fundus of the uterus and the perforation of adjacent ileal gut loop in one patient. This patient had a history of suction and evacuation for medical termination of pregnancy. The patient was referred for a CT scan after two days with complaints of generalised abdominal pain. The patient underwent surgery, revealing a 1x0.5 cm rent in the fundic region of the uterus with an adherent small bowel loop and a 1x1cm perforation of the distal ileum. Separation of the adherent gut from the fundus and surgical repair of perforation of the ileum and uterus was done, leading to the patient's improvement. In another case of a ruptured ectopic pregnancy, ultrasound showed a complex ovarian cyst with ascites; however, MDCT revealed the presence of high attenuation (50-60 HU) ascites and a heterogeneous lesion in the right adnexa, suggesting a diagnosis of ruptured tubal ectopic pregnancy, which was confirmed by elevated beta Human Chorionic Gonadotropin (HCG) levels. In patients with simple ovarian cysts on MDCT, acute appendicitis was ruled out, thereby avoiding surgical intervention.

Testicular vein thrombosis and common iliac artery thrombosis mimicked acute appendicitis clinically; however, MDCT made the accurate diagnosis, thus avoiding unnecessary appendectomy. In another case of aortic dissection, CT demonstrated the true and false lumens and the extent of vessel involvement. In the case of abdominal aortic aneurysm, CT accurately characterised it as a contained rupture of the abdominal aortic aneurysm, following the contour of the adjacent vertebral bodies referred as draped aorta sign [26]. The sensitivity and specificity of MDCT in diagnosing vascular aetiologies were both 100%, consistent with a study by Sravan Krishna Reddy A et al., which also reported a sensitivity and specificity of 100% [14]. Therefore, MDCT is the investigation of choice for vascular emergencies, especially when planning interventions.

This study was conducted at a tertiary care institute that provides un-interrupted referral services across the state. According to published literature, the study was conducted for the first time at our institute, highlighting the importance of MDCT in detecting pathologies without wasting time on conventional imaging, addressing the need to act within the golden hour.

Limitation(s)

The present study is based on smaller number of patients with GB, vascular, testicular, and gynaecological diseases. Additionally, MDCT is not the modality of choice in certain conditions such as ectopic pregnancy, testicular or ovarian torsion, and epididymo-orchitis. Therefore, this study cannot be considered highly representative of these conditions. In some conservatively managed cases, another limitation was the lack of definite laboratory and HPE evidence to confirm the MDCT diagnosis.

CONCLUSION(S)

Acute abdomen is the most commonly encountered emergency condition that requires prompt and accurate diagnosis. Since the clinical presentations of many conditions presenting with acute abdomen largely overlap, and laboratory investigations, abdominal radiography, and USG may be in-conclusive, MDCT should be performed in patients with acute abdomen to minimise morbidity and mortality. MDCT has high sensitivity, specificity, and diagnostic accuracy in diagnosing acute non-traumatic abdominal and pelvic emergencies. Additionally, due to its multi-planar reconstruction, it allows the viewer to display the study in any desired straight or curved isotropic plane.

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