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Analysis of different pathologies presenting as acute abdomen and performance of MDCT in making the diagnosis with clinical, intra-operative and histopathology correlation

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Abstract

Background: Acute abdomen is one of the most common emergencies presenting in the emergency room which requires immediate attention. Making an accurate diagnosis is of paramount importance in managing these patients, since most of these patients frequently require a surgical intervention. The divergence of patient population and the underlying pathology in acute abdomen calls for high quality imaging studies to make quick and precise diagnosis. Multi-detector computed tomography is an ideal tool in this regard.

Materials and Methods: It is a prospective study conducted on 73 patients who presented with acute abdomen and subsequently underwent multi-detector computed tomography to ascertain the underlying pathology. The radiological findings in computed tomography were correlated with clinical, intra-operative and histopathological findings whenever available.

Results: In our study the performance of multi-detector computed tomography, when compared with diagnosis made based on intra-operative findings, post-operative histopathology and clinical findings showed sensitivity of 97% and specificity of 75%. Overall Positive Predictive value of 98.5% and negative predictive value of 60% and accuracy of 96%.

Conclusion: Since most of the patients presenting with acute abdomen have non-specific and overlapping clinical findings, making an accurate clinical diagnosis is challenging. In this scenario MDCT comes as a handy tool with high accuracy and good sensitivity and specificity. The results obtained in our study are comparable with other studies conducted worldwide.

Keywords: Acute abdomen, MDCT performance, acute abdominal pain

Introduction

Acute abdomen is a clinical entity in which patients present with sudden onset of intense abdominal pain necessitating emergency medical/surgical management [1]. Majority of these patients present to the emergency department. The underlying pathology in acute abdomen could be anything ranging from acute inflammatory conditions involving the appendix, gallbladder, pancreas to non-specific pain usually associated with mesenteric adenitis, especially in children. In a given patient there are numerous differential diagnoses and making a single specific diagnosis is seldom seen and it is very difficult, given the overlap of presenting symptoms and clinical examination findings in various pathologies. Further evaluation with laboratory blood tests and radiological investigations is part of management of these patients.

Patients presenting with acute abdomen are in severe pain and very sick. Hence it is essential to make a prompt and accurate diagnosis in these patients [2]. Most of these patients are initially evaluated with abdominal radiograph and ultrasound. The role of these basic radiological investigations is limited by various factors. Major limiting factors are two dimensional nature of radiographs. In ultrasound limiting factors are inability of the patient to cooperate for the study due to severe pain, thick body habitus of the patient, excessive bowel gas and lack of adequately filled urinary bladder. However radiograph has fairly good specificity in diagnosing pneumoperitoneum. It gives useful information in only in less than 50% of patients [2].

Ultrasound has its own advantages. It is cheap, easily available, no need to administer contrast and it is free of ionizing radiation, hence better suited for children and pregnant women. Ultrasound is a valuable tool in the assessment of pathology related to gallbladder and acute ureteric colic, especially when the obstruction is at the vesico-ureteric junction, which is by far the most common site.

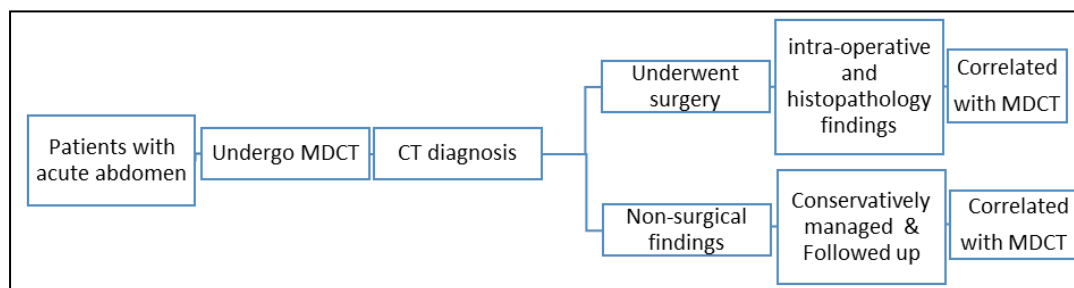
Though these basic radiological investigations do indeed provide valuable information, in a good number of patients computed tomography (CT) examination is essential. Multi-Detector CT (MDCT) is a widely accepted primary investigation of choice in these patients [3, 4, 5]. The scanning is fast, (acquisition time of 2-3 minutes), and yields specific diagnosis. In MDCT, multiple images can be acquired in a single tube rotation. The whole abdomen and pelvis can be scanned within a single breath hold at a slice thickness of less than a millimeter (0.3-1mm). These sub millimeter sections can be used to obtain good quality reconstructed images like multi-planar reconstructions (MPR) maximum intensity projection (MIP) and 3dimensional (3D) reconstruction. MDCT is a great tool for comprehensive evaluation of entire abdomen. There is excellent visualization of the solid organs, hallow viscera, vasculature, peritoneum and retroperitoneal structures along with lung bases.

Our study aims at analyzing the incidence and frequency of various pathologies presenting as acute abdomen in a tertiary care hospital and the accuracy of 128 slice MDCT in making a correct diagnosis by correlating the CT diagnosis with intra-operative and post-operative histopathology diagnosis, whenever available and clinical diagnosis if the patient does not undergo surgery. Intra-operative and post-operative histopathology are considered as gold standard.

Materials and Methods

It is a prospective study performed on 73 subjects who presented with acute pain abdomen, who were referred to radiology department for MDCT abdomen. The duration of this study was from May 2015 to June 2016. Prior to the commencement of the study, necessary clearance was obtained from the institutional ethics committee and written informed consent was taken from the participating patients. Inclusion criteria: Patients who are presenting with clinical symptoms of acute abdomen and undergoing MDCT. Exclusion criteria: Patients who have contraindication to iodinated contrast media either due to contrast allergy or due to impaired renal function. Patients lost to follow up.

CT protocol: MDCT was performed with Siemens SOMATOM definition edge 128 slice scanner. Oral iodinated contrast was not given in patients who are kept nil by mouth in view of immediate surgical exploration, who cannot tolerate oral liquids (pancreatitis), suspected high degree of bowel obstruction, and suspected vascular pathology where the study is done in abdominal angiogram protocol (oral contrast interferes with vascular reconstructions). All the other patients were administered oral and rectal contrast as per routine protocol. All patients underwent a non-contrast study followed by contrast study. Approximately 80-90ml (1-2ml/kg body weight) iodinated non-ionic contrast was given intravenously using a pressure injector at 4ml/sec rate. Images were obtained at arterial (20-25sec), venous (50-60seconds) and delayed phases (>120 sec) using bolus tracking and automatic triggering of acquisition. Raw data was acquired with slice thickness of 0.625mm with a pitch of 0.8-1.5. The images were reconstructed in 5mm thickness for viewing purpose and in 1mm thickness for doing various reconstructions [6].



Study design

Results

In this study 73 patients with acute abdomen underwent MDCT. The findings of MDCT were correlated with the intraoperative findings and histopathological findings in

patients who had undergone surgery. In conservatively managed patients the MDCT findings were correlated with clinical course. Table 1 shows the age distribution in the study population.

Table 1: Age group wise distribution of acute abdomen in the study population

Age (years)	Frequency	Percentage
0 to 10	4	5
11 to 20	6	8
21 to 30	8	11
31 to 40	16	22
41 to 50	12	16
51 to 60	9	12
61 to 70	11	15
71 to 80	6	8
91 to 100	1	1
Total	73	100

The sex distribution of the study population is shown in figure 1.

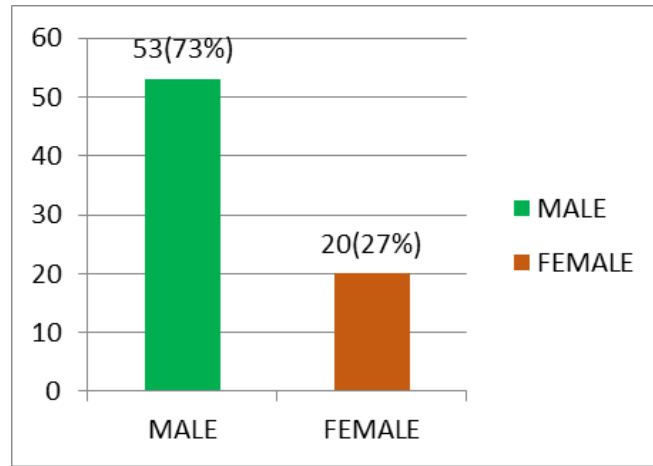


Fig 1: Gender distribution of acute abdomen.

Table 2 shows the frequency and percentage of the various pathologies detected among the study population.

Table 2: Distribution of various pathologies in study population.

No	Pathology	Frequency	Percentage
1	Appendicitis	16	22
2	Bowel obstruction	13	18
3	Acute pancreatitis	11	15
4	Perforation	10	14
5	Urolithiasis	5	7
6	Cholecystitis	4	5
7	Bowel ischemia	2	3
8	Aortic dissection	1	1
9	Diverticulitis	2	3
10	Aortic aneurysm	2	3
11	Intussusception	2	3
12	Volvulus	2	3
13	Nonspecific pain	3	4
	Total	73	100

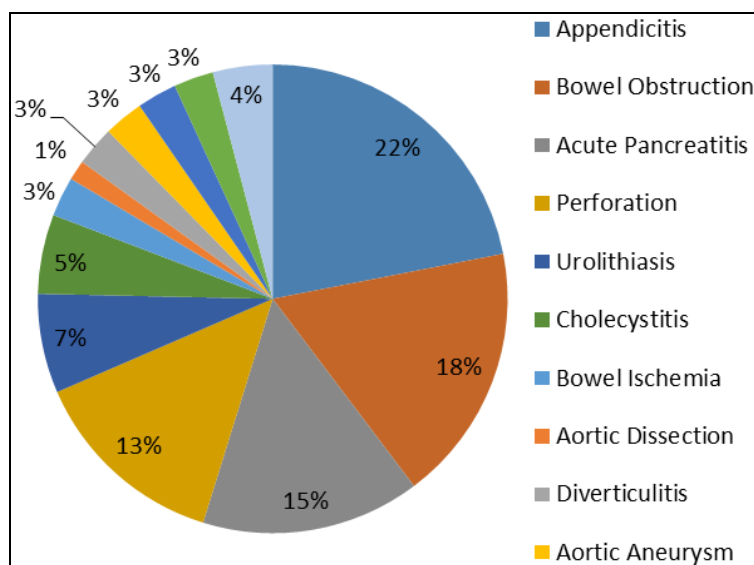


Fig 2: Pie chart showing percentage of various pathologies in acute abdomen

The pie chart (fig. 2) shows the percentage of patients affected by various pathologies, observed in the study population.

Table 3 shows the gender wise number of patients affected by various pathologies.

Table 3: Gender wise distribution of pathologies.

No	Pathology	Frequency	Male	Female
1	Appendicitis	16	10	6
2	Bowel Obstruction	13	9	4
3	Acute Pancreatitis	11	11	0
4	Perforation	10	7	3
5	Urolithiasis	5	3	2
6	Bowel Ischemia	2	2	0
7	Aortic Dissection	1	1	0
8	Cholecystitis	4	4	0
9	Diverticulitis	2	2	0
10	Aortic Aneurysm	2	2	0
11	Volvulus	2	0	2
12	Intussusception	2	1	1
13	Non-Specific Abdominal Pain	3	1	2
	Total	73	53	20

Demographics of few most common pathologies.

1. Appendicitis: Age and sex wise distribution of appendicitis in the study population is shown in figure 3.

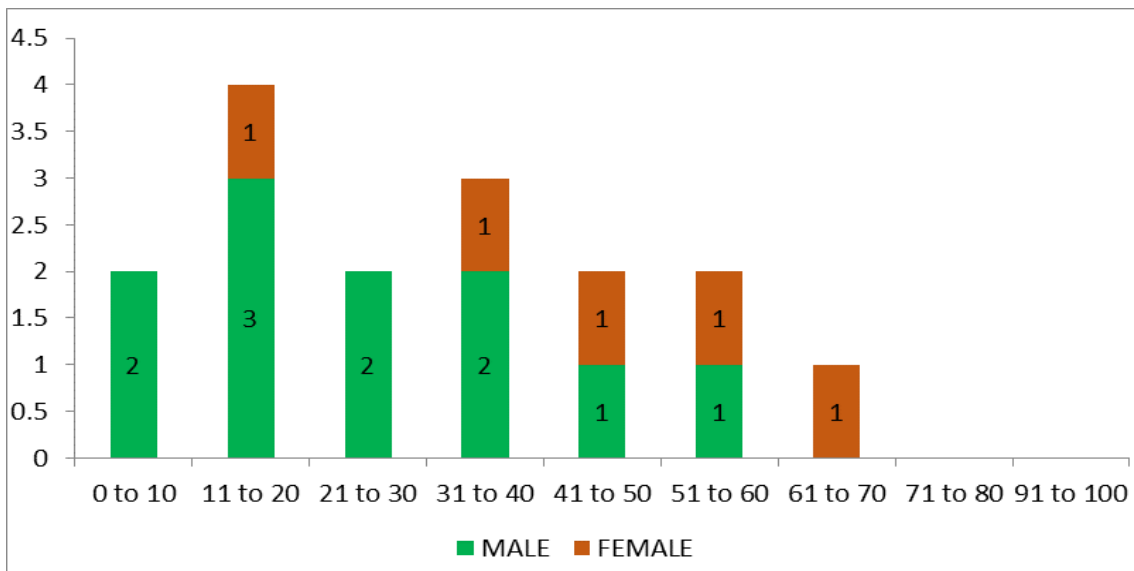


Fig 3: Gender and age wise distribution-appendicitis

2. Bowel obstruction: Age and sex wise distribution of bowel obstruction in the study population is shown in figure 4.

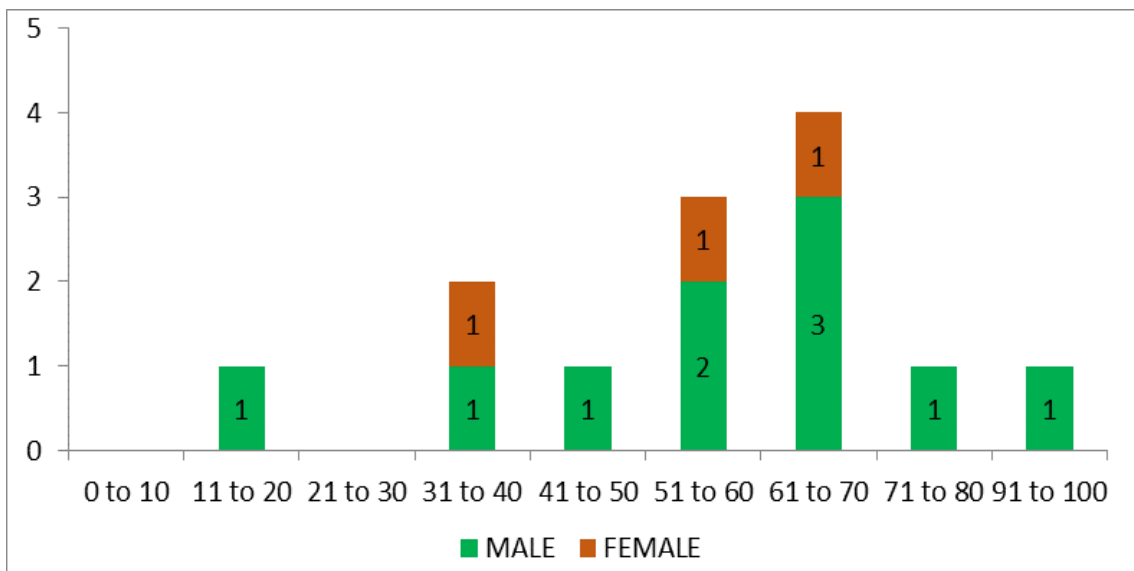


Fig 4: Gender and age wise distribution of bowel obstruction

3. Pancreatitis: Age and sex wise distribution of pancreatitis in the study population is shown in figure 5.

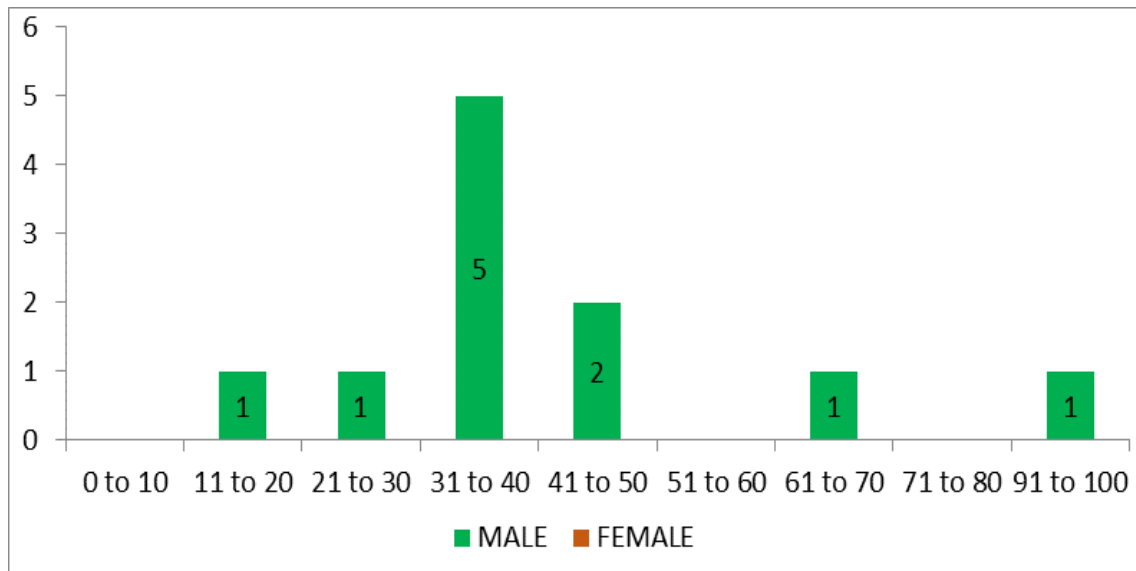


Fig 5: Gender and age wise distribution of pancreatitis

4. Bowel perforation: Age and sex wise distribution of bowel perforation in the study population is shown in figure 6.

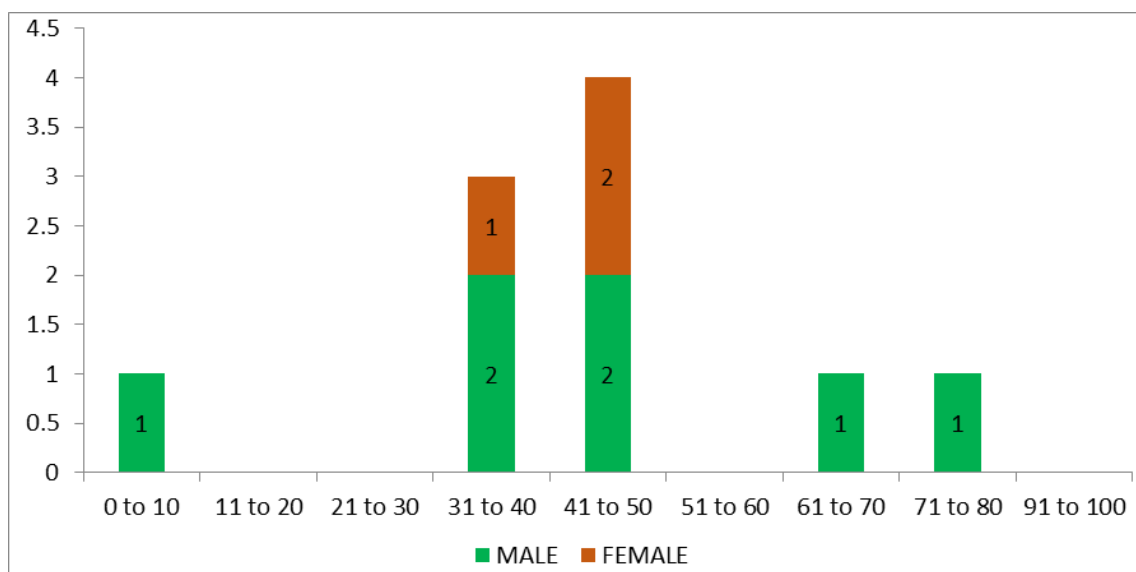


Fig 6: Gender and Age wise distribution of bowel perforation

Table 4 shows the overall diagnostic performance of MDCT compared with intra-operative and post-operative HPE diagnosis and clinical diagnosis.

Table 4: Overall diagnostic performance of MDCT

MDCT performance in acute abdomen	
Sensitivity	97.10%
Specificity	75.00%
Positive Predictive Value	98.53%
Negative Predictive Value	60.00%

Discussion

The current generation of the MDCT scanners with cutting edge technology have become the main stay of evaluation of patients with acute abdomen. The technology enables acquisition of isotropic images with exquisite spatial resolution and significantly reduced radiation exposure. The multi-row multi-detector spiral scanning technology has

reduced scanning time significantly, leading to improved output and reduced movement related artefacts. The large volumetric data obtained in the axial plane allows reformations into any required plane with same resolution [7]. The advances in reformation techniques have made the process automatic which saves time. Further increase in the computing speed has facilitated faster radiological interpretation in critically ill patients. The shear speed and accuracy of CT in acute abdomen has made the role of plain radiography nearly obsolete.

In our study group of 73 patients 53 were males and 20 were females, ranging from 5 to 93 years. We analyzed various pathologies presenting as acute abdomen. Most common pathology found in our study was acute appendicitis, seen in 22% followed by bowel obstruction in 18%, acute pancreatitis 15% and bowel perforation 14%. Among which appendicitis is the most common cause and is consistent with most of the studies carried out internationally [8].

However we did not encounter any definitive gynecologic pathology, which may be due to the fact that patients with gynecological pathology were primarily evaluated by ultrasound which itself can yield a specific diagnosis.

In our study 16 patients had CT findings suggestive of acute appendicitis and related conditions (Figure 7). CT diagnosis in one out of these 16 cases was non-concordant with intraoperative surgical findings. Intra-operatively it was found to be ileo-cecal tuberculosis which was confirmed by histopathological examination. The actual CT findings in this case were masked by clumping of bowel loops in the

right iliac fossa, which made visualization of appendix difficult. This was erroneously diagnosed as inflammatory appendicular mass.

The sensitivity and Positive Predictable Value in acute appendicitis were 100% and 93.75% respectively. Intra operative findings very well correlated with CT findings except for one case. This is consistent with study conducted by Rao PM *et al.* [9] which shows 91% to 100% sensitivity for CT in the diagnosis of appendicitis. In another study done by Mawiah H. Alshebromi *et al.* [10] CT showed high sensitivity of 100% and poor specificity of mere 16%.

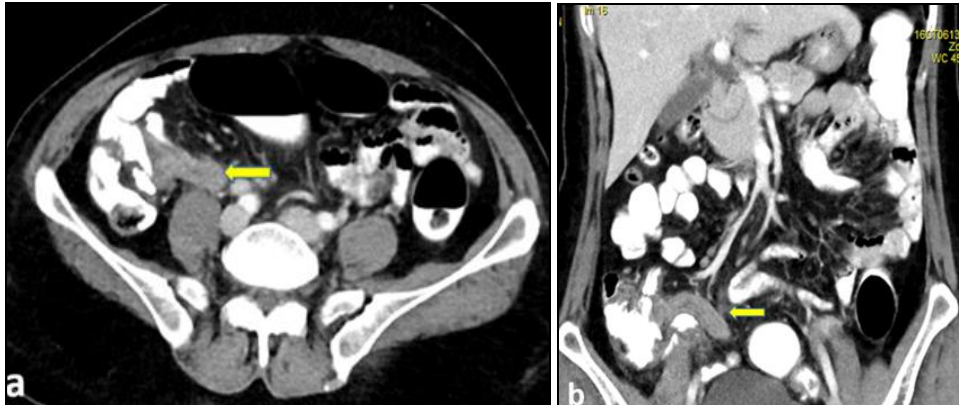


Fig 7: Axial and coronal MPR images showing a typical case of appendicitis with thickened and enhancing appendix (arrow in a). Coronal MPR (arrow in b) in same patient

In our study 13 out of 73 cases were diagnosed to have bowel obstruction. The various etiologies of bowel obstruction are stricture, adhesion, hernia and mesenteric band [11]. The sensitivity and positive predictable value were 100%. Our results are comparable with Mallo *et al.* [12] in which sensitivity of MDCT in diagnosis of bowel obstruction was 81% to 100% and specificity 68% to 100%. A study conducted by Suri S *et al.* [13] shows that CT is

highly sensitive in determining level and cause of obstruction. This is made possible by the exquisite coronal and sagittal reformatted MPR images [14] which are very useful in identifying the transitional zone (Figure 8a). MPR images in any oblique or orthogonal plane are good in identifying intussusception and the underlying pathology as well (Figure 8b)



Fig 8: Case of acute bowel obstruction. Coronal MPR shows the transitional zone, in this case it was adhesion causing obstruction (a); Colonic intussusception and the underlying pathology, lipoma are shown well in coronal MPR (b).

We encountered 11 cases of pancreatitis out of 73 cases. In all the cases MDCT correctly identified the pathology. In all of the cases diagnosis was confirmed by abnormal levels of elevated pancreatic enzymes. The sensitivity of MDCT in acute pancreatitis was 100%. Comparable results were shown by B. Gianni *et al.* [15]. This is a disease entity where CT clearly scores over ultrasound, because visualization of

pancreas itself, in most of the cases of pancreatitis is interfered by bowel gas. Estimation of pancreatic necrosis is impossible with ultrasound, which is the key factor in management and prognostication. CT also is better in identifying and quantifying the peripancreatic collections, pseudo cysts and identifying air in emphysematous pancreatitis (Figure 9).

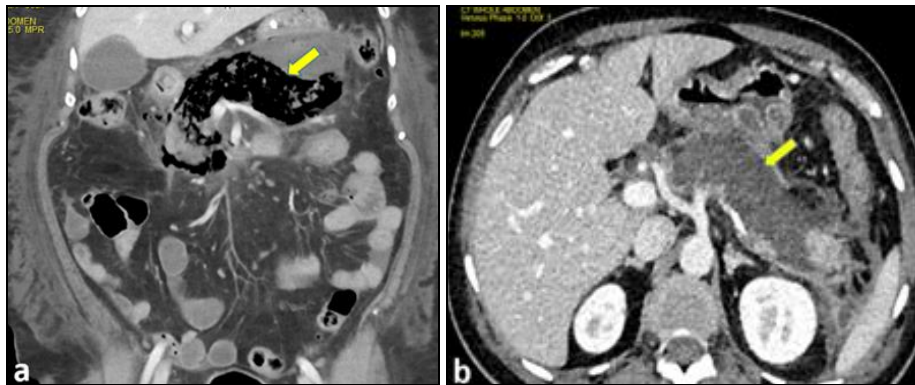


Fig 9: Coronal MPR showing extensive air replacing the entire pancreas, suggestive of emphysematous pancreatitis (arrow in a). Axial post contrast image shows extensive necrosis of the pancreatic parenchyma (arrow in b)

In our study 8 out of 10 cases of confirmed perforation were correctly diagnosed by MDCT. Two missed cases presented very late in the course of the disease, nearly after a week. Because of this delay in presentation these cases lacked the typical imaging features. Hence the perforation had already been sealed off and the pneumoperitoneum had been absorbed, the diagnosis was missed. In hollow viscus perforation the site of perforation can be exactly identified with MDCT. The early and occult perforations and sealed off perforations can be made out with MDCT, due to its ability to detect even smallest amount of free air. The sensitivity and accuracy for bowel perforation in our study was 80%, which was comparable to the study done by Sung

Hwan Kim *et al.* and other investigators [16, 17, 18] who gave an accuracy of 82% to 90% for predicting site of perforation by CT.

In our study 5 out of 73 cases had urolithiasis, all the 5 cases were correctly identified by MDCT with sensitivity of 100%. The above findings are comparable with study performed by Isabelle Boulay *et al.* and others [19, 20, 21]. Leschka Sebastian *et al.* [5] state that thin slices and good multi-planar reconstructions helps in identifying even sub-millimeter calculi (Figure 10). This is complemented by the fact that nearly 100% of the renal calculi are radio-opaque.



Fig 10: Coronal MPR image showing the dilated calyces, and ureter in its entirety with an obstructing calculus in the mid ureter (arrow).

In our study 4 out of 73 cases had CT findings suggestive of cholecystitis with sensitivity of 100% which is comparable to other international studies. However the limitation of CT in gall bladder pathology is its failure to detect radio-lucent calculi, which could be the underlying predisposing factor for cholecystitis. Ultrasound and Magnetic Resonance Imaging (MRI) have better sensitivity in identifying Cholelithiasis. MDCT clearly performs better than ultrasound in detecting the complications like emphysematous cholecystitis and gangrenous cholecystitis. MDCT is the most sensitive modality in identifying complications related to cholecystitis as stated by L. Turturici *et al.* [22]

In 3 out of the 73 patients no significant abnormalities were detected by MDCT. And this was the case even in

diagnostic laparoscopy. These patients were considered to have non-specific abdominal pain. The pathology in these patients presumed to be due to transient pain caused by intestinal colic or pain caused by a passing ureteric calculus, which would have completely passed out from the urinary bladder also, hence not seen in CT.

In our study the overall accuracy, sensitivity, specificity and positive and negative predictable values of MDCT were 96%, 97%, 75% and 98% and 60% respectively which were comparable to the study results of Monica Mangini *et al.* [23]

Conclusion

Acute abdomen is a commonly encountered, usually a surgical emergency. In our study the most commonly encountered pathologies were appendicitis, bowel

obstruction, bowel perforation and acute pancreatitis. It is essential to make a speedy and accurate diagnosis in these patients to decide on the management as to subject them to surgery or treat conservatively. For this purpose we need to employ a robust diagnostic tool. The clinical examination and laboratory parameters have very poor sensitivity and specificity, hence cannot be dependent upon. Very good sensitivity and specificity of MDCT makes it an ideal tool in the evaluation of acute abdomen. Recent advances in hardware, software and computation speed have made MDCT a powerful diagnostic tool in acute abdomen. MDCT scores over all other imaging modalities because of its speed and versatility.

Limitations of the study: Our study employed relatively small sample size, mainly because many patients were taken up for surgery based on ultrasound/radiography findings alone without CT. Though ultrasound may not give a specific diagnosis, these patients were taken up for surgery without CT, in the background of a given clinical scenario, like presence of guarding and rigidity in a suspected case of hollow viscus perforation where ultrasound showed free fluid and radiograph showed pneumoperitoneum which necessitated immediate laparotomy. Barring few specific conditions like gallbladder pathology and gynecological pathology MDCT is the primary modality of choice for evaluating acute abdomen.

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