Original Research Article

Role of multi detector computed tomography (MDCT) in evaluation of small bowel disorders

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Abstract

Background: MDCT (Multi Detector Computed Tomography) with enteroclysis/ enterography has been utilized in abdominal imaging. It gives a clear picture of small bowel wall and lumen due to proper distension. In addition, mesenteric vasculature can be studied. Moreover, it also gives information on extra intestinal pathology. **Aim:** To evaluate the role of MDCT in evaluating small bowel disorders. **Material and Methods:** A prospective study of 60 patients who were diagnosed to have small bowel pathology on MDCT was done. All patients subsequently underwent surgery with histopathological examination. The intraoperative and HP findings were correlated. **Results:** Small bowel neoplasms were correctly diagnosed preoperatively in all 15 cases. Among neoplasms, carcinoma duodenum was the most common diagnosis. Small bowel ischemia with gangrene was the final diagnosis in 10 patients. Of these, 9 patients were diagnosed as having gangrene preoperatively. In the tenth patient the bowel was reported as normal. Strictures were correctly identifiedon MDCT in 10 out 11 patients. In one patient small bowel obstruction due to stricture was misdiagnosed as being due to adhesions. Overall, MDCT had an accuracy of 88.3% in diagnosing small bowel pathologies. **Conclusion:** MDCT plays an extremely important role in diagnosing various small bowel pathologies. Both obstructive and non-obstructive lesions are evaluated well by MDCT. MDCT is extremely accurate in diagnosing the level, and cause of obstruction.
Keywords: Small bowel disorders, Multi Detector Computed Tomography, enteroclysis, enterography

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INTRODUCTION

For several years, small intestine had always been an unreachable domain for diagnostic purposes in the hands of clinicians and radiologists due to the limited accessibility. Patients present with very nonspecific complaints such as pain abdomen, weight loss or anemia, hence the onus falls on the radiologists to diagnose the disease.[1] Conventional enteroclysis does not provide direct information about bowel wall and is limited by overlapping of bowel loop.[2] Capsule endoscopy also have limitations like in strictures causing capsule obstruction. Small bowel enteroscopy overcame this problem, but again their availability and technical expertise required to operate have limited its wide use.[3] To overcome the limitations of enteroclysis and capsule endoscopy, MDCT (Multi Detector Computed Tomography) with enteroclysis/enterography has been utilized. MDCT with enteroclysis/enterography gives a clear picture of small bowel wall and lumen due to proper distension. In addition, mesenteric vasculature can be studied. Moreover, it also gives information on extra intestinal pathology.[4] The multiplanar reformats further help in proper visualization of bowel from all possible angles. The present study aimed at evaluating the usage of MDCT in diagnosing small bowel pathology and to correlate the CT diagnosis with intra operative findings and histopathology.

MATERIAL AND METHODS

A prospective study of 60 patients was done at tertiary care hospital over a period of two years, who were diagnosed to have small bowel pathology on MDCT. All 60 patients subsequently underwent surgery with histopathological examination. Necessary clearance was taken from Ethical Committee and written informed consent was taken from

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every patient. Intraoperative and histopathological findings were used as standard of reference.

Inclusion criteria: All patients with small bowel pathologies on MDCT who underwent surgery with histopathological examination

Exclusion criteria: Patients with small bowel pathologies who did not undergo surgical intervention and in whom histopathology correlation was not available.

Methodology

All the cases were done on 64 slice GE light speed VCT system. With patient in supine position, feet first orientation with xiphisternum as anatomical reference scanning was done. Scanning protocol for Plain CT included - Scan type: Helical; Slice thickness:5 mm; Detector coverage: 40mm; Pitch:1.375:1; Rotation time: 0.6sec/rotation; SFOV:Large body; kV: 120; mA: Auto; DFOV: 38cm; Recon: 0.625mm acquisition with standardalgorithm in standard window; Scan time:10sec; DLP:2806.9; CTDI: 74.8; Effective dose: 4msv; Window level:340 -360 with window width: 40 -60 should cover from dome of diaphragm to ischial tuberosities. Facrors used were AP view:120 kV, 10 mA; Lateral view: 120 kV, 10 mA. Scanning protocol for Plain CT included - Scan type : Helical; Slice thickness:5mm; Detector coverage:40 mm, Pitch:1.375:1; Rotation time:0.6sec/rotation; SFOV: Large body; kV:120; mA: auto; DFOV:38cm; Recon:0.625mm acquisition with standardalgorithm in standard window; ROI: descending aorta; Arterial phase at 150 threshold at 17-18 sec and Venous phase at 150 threshold at 70 sec.

Enterography

Patients were informed not to take any meals at least four hours prior to examination. Water was used as neutraloral contrast.1000 - 1500 ml of contrast was used over a period of 1 hour. At the beginning 450 ml was given, after 20 mins-450 ml was given and after 40 mins 250ml was given. In the end as table dose 250 ml was given.

Enteroclysis

It was done by using bilbao-dotter tube/Freka tube (120cm, 22f) under fluroscopy guidance. Naso-jejunal tube was kept just beyond the duodeno - jejunal flexure.1000 - 1500ml of contrast was used over 20-30 mins. Water mixed with carboxymethyl cellulose was used as neutral oral contrast. Intravenous contrast was given at dose of 1.5 ml per kg at rate of 3.5 - 4 ml per sec. Non-ionic iodinated contrast medium like omnipaque (iohexol 300, 350mg), Visipaque (iodiaxanol 320mg) was used. Arterial phase was done at 18 -25 sec, Venous phase was done at 70 -90 sec.In patients who have clinical features suggestive of acute small bowel obstruction no oral contrast was given.

RESULTS

Amongst the 60 patients, 43 (71.7%) were male patients and 17 (28.3%) were female patients. The mean age was 42.4 years with the youngest being 4 months old and the oldest being 71 years. The commonest age group in our study fell into the 4th decade (15 cases) followed by 12 cases in the 5th decade and 11 cases in the 6th decade. In our study, small bowel tuberculosis was the most common CT diagnosis made in 15 (25%) patients, followed by stricture small bowel in 10 (16.6%) patients, small bowel ischemia in 9 (15%) patients, and carcinoma duodenum in 8 (13.3%) patients. Ileo-ileal intussusceptions were diagnosed in 5 (8.3%) patients and 3 (5%) patients were diagnosed with Gastro Intestinal Stromal Tumor (GIST). Small bowel lymphoma and small bowel perforation occurred in 2 (3.3%) patients each. Crohn's, carcinoid, ileal carcinoma and closed loop obstruction, adhesive obstruction, SMV thrombosis with normal bowel enhancement were diagnosed on CT in 1(1.7%) patient each.

Table 1: CT diagnosis

CT diagnosis	Frequency	Percent
Carcinoma duodenum	8	13.3
Ileo-ileal intussusceptions	5	8.3
Small bowel tuberculosis	15	25.0
Small bowel perforation	2	3.3
Crohn's disease	1	1.7
GIST	3	5.0
Carcinoid tumor	1	1.7
Lymphoma small bowel	2	3.3
Small bowel ischemia	9	15.0
Partial SMV thrombuswith normal bowel wall	1	1.7
Stricture small bowel	10	16.6
Adhesive obstruction	1	1.7
Ileal carcinoma	1	1.7
Closed loop obstruction	1	1.7
Total	**60**	**100.0**

The final histopathology diagnosis was the same as CT diagnosis in GIST (3), small bowel lymphoma (2), Crohn's disease (1), carcinoid tumor (1) and ileal carcinoma (1). Out of 8 cases of carcinoma duodenum diagnosed on CT 7 cases were adenocarcinomas, one turned out to be lymphangitis carcinomatosa (variant of carcinoma). Out of 15 cases of small bowel tuberculosis 11 patients showed tuberculosis on histopathology, 3 patients had chronic inflammatory changes and 1 patient had Meckel's diverticulitis. Lipoma was the cause of intussusception in 4 patient s while 1 patient had a polyp (Peutzjegher) on histopathology. Histopathology showed gangrene in 10 patients. Out of 11 cases of stricture 11 patients had inflammatory stricture in histopathology.

Table 2: Final histopathological diagnosis

HP diagnosis	Frequency	Percent
Moderately differentiated adenocarcinoma	8	13.3
Lipoma	4	6.7
Non Hodgkin lymphoma	2	3.3
Lymphangitis carcinomatosa	1	1.7
GIST	3	5.0
Inflammatory stricture	11	18.3
Small bowel perforation	2	3.3
Gangrene bowel	11	18.3
GranulomatousInflammationprobably tuberculous origin	11	18.3
Chronic inflammation	2	3.3
Peutzjegher polyp	1	1.7
Meckel's diverticulum	1	1.7
Crohn's disease	1	1.7
Chronic lymphoid hyperplasia	1	1.7
Carcinoid	1	1.7
Total	**60**	**100.0**

On correlating with intraoperative and histopathology findings, of the 8 cases of carcinoma duodenum one turned out to be lymphangitis carcinomatosa, (variant of carcinoma) other 14 patients had same final diagnosis as reported on CT previously. Inaccurate /incomplete diagnosis on MDCT was seen in 7 patients, of which 2 patients presented with obstructive lesion and 5 patients with non-obstructive lesion.

Table 3: Inaccurate /incomplete diagnosis

CT diagnosis	Intraoperative finding	Final HP diagnosis	No. of patients	Obstructive/ Non-obstructive
SMV thrombosis with normal appearing bowel	SMV thrombus with Gangrene of small bowel	Features suggestive of gangrene	01	Non obstructive
Ileo-ileal intussusception with lipoma as its lead point	Intussusception with Polyp as its lead point	Peutz-Jegher polyp as the lead point	01	Obstructive
Adhesions causing small bowel obstruction	Stricture causing small bowel obstruction	Inflammatory stricture	01	Obstructive
Small bowel tuberculosis	Small bowel tuberculosis	1-chronic lymphoid hyperplasia 2-chronicinflammatory change	03	Non obstructive
Small bowel tuberculosis	Meckel's diverticulum	Meckel's diverticulum with ectopic pancreatic tissue	01	Non obstructive

On CT 32 out of 60 patients (60%) showed findings consistent with small bowel obstruction. The remaining 28 (40%) patients showed non obstructive lesions. MDCT correctly identified small bowel obstruction including its site in all 32 patients. Out of 28 cases, in 23 patients, histopathology and intraoperative findings correlated with MDCT. In 4 patients, which were reported as tuberculosis on MDCT, on histopathology correlation 2 patients were reported as having chronic inflammatory change, 1 patient had chronic lymphoid hyperplasia whereas 1 patient was finally diagnosed as having a Meckel's diverticulum with inflammation. In 1 patient only a partial thrombosis of superior mesenteric vein with a normal appearing bowel was reported on CT. Surgery and histopathology showed gangrene.

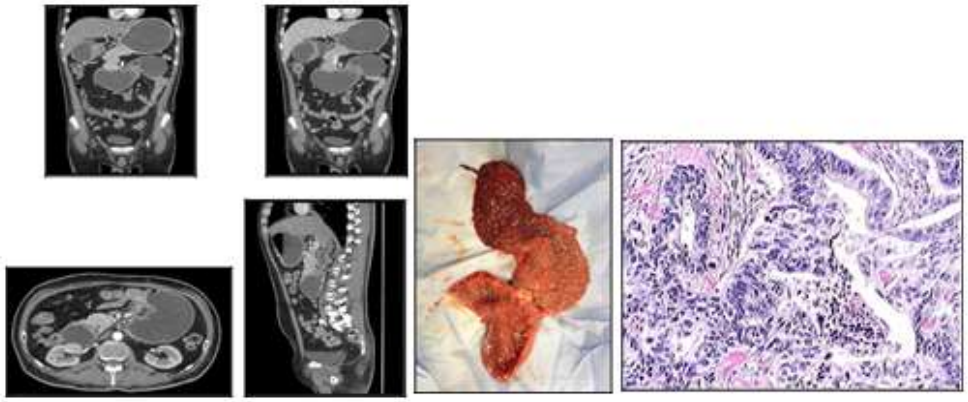

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Figure 1: a. MDCT – Enhancing circumferential mass lesion causing luminal narrowing of D2 and D3 segments with dilatation of proximal duodenum; **b.**Surgical specimen following segmental duodenectomy confirms the presence of mass lesion with luminal narrowing; **c**. Histopathology showing irregular glands with desmoplastic stroma, diagnostic of moderately differentiated adenocarcinoma. (HandE, x200).

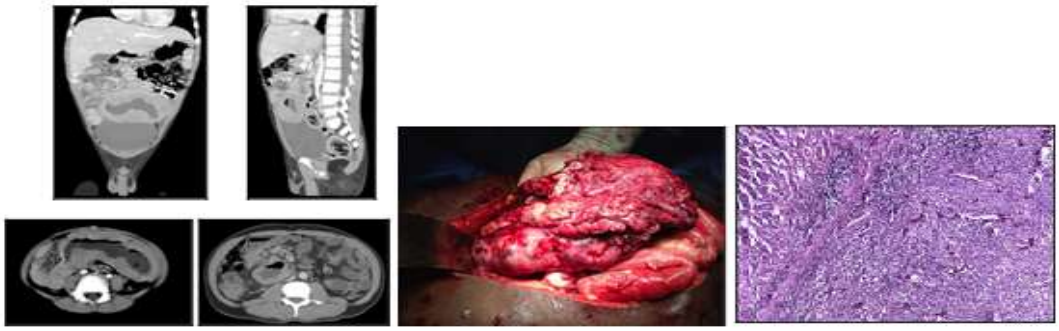

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Figure 2: a.MDCT: Grossly thickened bowel wall with aneurysmal dilatation and multiple enlarged mesenteric and omental nodes are highly suggestive of lymphoma; **b.** Intra op- confirmed the CT findings of lymphoma; **c.** Histopathology showing monoclonal population of neoplastic lymphoid cells in the submucosa- suggestive of non Hodgkin's lymphoma. (HandE x 40)

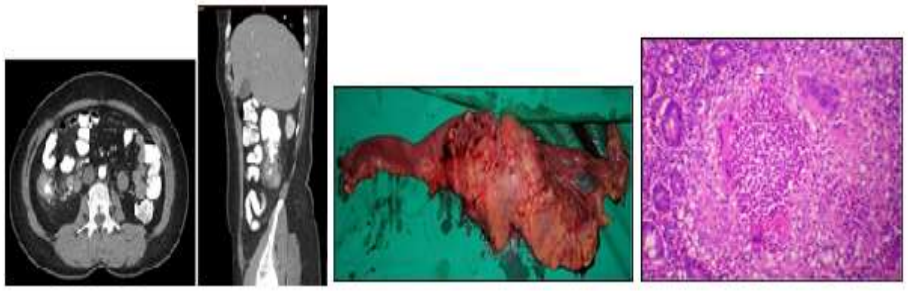

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Figure 3: a. MDCT: Thickened walls of terminal ileum, ileocecal junction and caecum with adjacent lymphadenopathy, raising the possibility of tuberculosis; **b.** Resected ileum and ceacum; **c.** Histopathology showing granulomas with giant cells and central necrosis and necrophilia collection, consistent with ileocecal tuberculosis. (HandE, x200)

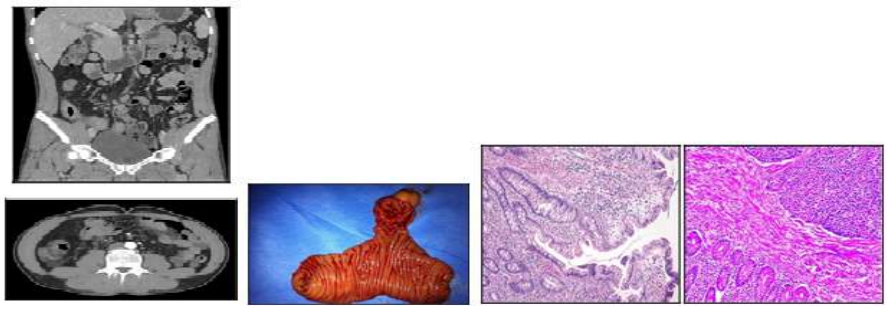

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Figure.4: a. MDCT diagnosis was infective/inflammatory etiology probably tuberculosis; **b.** Resected specimen showing Meckels diverticulum; **c.** An outpouching of small intestine with areas of inflammation and granulation tissue (HandE, x200) andIntestinal mucosa shows ectopic pancreatic tissue (HandE,x100).

DISCUSSION

Small intestine being the lengthiest portion of the intestinal system, always poses a challenge in complete evaluation and diagnosis of pathological conditions. We studied the usefulness of MDCT in diagnosing small bowel pathologies, correlating with intraoperative and histopathological findings. Intraoperative with histopathology findings were taken as the gold standard for this study. In our study small bowel tuberculosis was the most common CT diagnosis made in 15 (25%) patients, followed by stricture small bowel in 10 (16.6%) patients, small bowel ischemia in 9 (15%) patients, and carcinoma duodenum in 8 (13.3%) patients. Ileo-ileal intussusceptions were diagnosed in 5 (8.3%) patients and 3 (5%) patients were diagnosed with Gastro Intestinal Stromal Tumor (GIST). Small bowel lymphoma and small bowel perforation occurred in 2 (3.3%) patients each. Crohn's, carcinoid, ileal carcinoma and closed loop obstruction, adhesive obstruction, SMV thrombosis with normal bowel enhancement were diagnosed on CT in 1 (1.7%) patient each. The final histopathology diagnosis was the same as CT diagnosis in GIST [3], small bowel lymphoma (2), Crohn's disease [1], carcinoid tumor [1] and ileal carcinoma (1). Out of 8 cases of carcinoma duodenum diagnosed on CT, 7 cases were adenocarcinomas, one turned out to be lymphangitis carcinomatosa. Out of 15 cases of small bowel tuberculosis 11 patients showed tuberculosis on histopathology, 3 patients had chronic inflammatory changes and 1 patient had Meckel's diverticulitis. Lipoma was the cause ofintussusception in 4 patient s while 1 patient had a polyp (Peutz-Jegher) on histopathology. Histopathology showed gangrene in 10 patients. Out of 11 cases of stricture, 11 patients had inflammatory stricture in histopathology. Sailer et al in his study stated that primary neoplasm of small bowel are uncommon, representing only about 3% of all neoplasms of digestive tract. Among the malignant tumors adenocarcinoma accounts for 1% with duodenum being the most common site of involvement, neuroendocrine tumors 25%-35%, lymphoma 15% - 20% and GIST 15%.[5] In our study, neoplastic lesions of small bowel were reported on CT in 15 patients.On correlating with intraoperative and histopathology findings, of the 8 cases of carcinoma duodenum, one turned out to be lymphangitis carcinomatosa, other 14 patients had same final diagnosis as reported on CT previously. Duodenal carcinoma was the commonest malignant tumor of small bowel in our study. In the observations by Rosai et al, 50% of small bowel adenocarcinoma was found in duodenum especially near the ampulla.[6]Julie et al has observed manifestation of an annular narrowing with irregular overhanging edges or an ulcerative lesion in the cases of duodenal adenocarcinoma.[7]Maglinte et al proposed that on administration of intra venous contrast the tumor showsheterogenous enhancement.[8]These features were observed in all of our patients which helped in achieving our diagnosis. Furthermore, the nodal status and the operability were assessed. Out of 8 cases, all were diagnosed to have malignant tumor of duodenum preoperatively by MDCT. Intraoperatively all these patients had a circumferential tumor correlating with the CT findings, all of them underwent radical excision (segmental duodenectomy in 4, pancreaticoduodenectomy in 4. On histopathogy 7 out of 8 cases were adenocarcinoma and 1 was lymphangitis carcinomatosa. The study done by Kazerooni et al showed that CT was 100% sensitive and 86% accurate for predicting malignant tumor in presence of morphological features along with finding of extraduodenal disease.[9] In our study MDCT was 100% sensitive and accurate in diagnosing malignant tumors of duodenum. Duodenal lymphangitis carcinomatosa is extremely rare. Makasmo et al described 4 patients with lymphangitis carcinomatosa all of whom exhibited multiple polypoidal lesions along the Kerckring's folds and/or were covered by granular non ulcerated mucosa endoscopically.[10] Similarly, one case of ileal carcinoma was diagnosed with the same findings as duodenal carcinoma. Intraoperative findings correlated

with MDCT findings. Histopathology confirmed the presence of adenocarcinoma. This patient underwent a radical right hemicolectomy. We diagnosed a case of carcinoid tumor of duodenum preoperatively. MDCT showed a well-defined small rounded intramural mass in the second part of duodenum. On contrast administration intense enhancement was noted in the arterial phase. Patient was operated and biopsy confirmed carcinoid. Amongst the inflammatory conditions of small bowel tuberculosis of intestine was the most common diagnosis in our study (15cases 25%). On MDCT, 15 out of 60 patients were reported as tuberculosis of the small bowel (including ileocecal junction). However, on histopathology correlation, only 11 of the 15 patients were confirmed to have tuberculosis. Of the remaining 4 patients, 2 patients were reported as having chronic inflammatory change, 1 patient had chronic lymphoid hyperplasia whereas 1 patient was finally diagnosed as having a Meckel's diverticulum with inflammation. Balthazar et al has shown the usefulness of CT in diagnosing ileocecal tuberculosis and knowing the location and extent of intestinal and mesenteric involvement.[11] In our observation, we had either one or two of the findings which were suggestive of tuberculosis in the preoperative setting. Among the 15 patients who were diagnosed as small bowel tuberculosis on MDCT, 14 patients had concentric ileal wall thickening and 1 patient had matted bowel loops with respect to intestinal findings. Mesenteric lymphadenopathy was noted in all our patients. MDCT was helpful in detecting the intestinal changes. Histopathology confirmed tuberculosis in 11 patients and the final diagnosis in 3 patients (2 patients-chronic inflammatory changes and 1 patient-chronic lymphoid hyperplasia) turned out to be reactive inflammation. Intraoperatively, one patient had Meckel's diverticulum which was missed in MDCT, and Meckel's diverticulitis with ectopic pancreatic tissue was confirmed on histopathology. Crohn's disease was diagnosed in one patient with the help of MDCT. This patient had classical CT findings of engorged vasa recta giving a comb sign as described by Hara and Fletcher et al.[12,13]Intraoperatively the findings were creeping mesenteric fat with luminal portion showing multiple ulcers with skip lesions, confirming the diagnosis of Crohn's disease. Histopathology also confirmed Crohn's disease. MDCT is better for detecting transmural and extra mural abnormalities. In addition, it also useful in depiction of obstructive and non-obstructive causes of Crohn's disease.[12] We diagnosed 5 cases of ileoileal intussusception correctly, with all of them exhibiting the classical target sign or the doughnut sign on CT imaging. We diagnosed the lead point of obstruction as lipoma in all 5 cases. However, on correlation with surgery and histopathology, 4 were confirmed as lipoma whereas 1 turned out to be a PeutzJegher polyp. On retrospectively reviewing the CT images, we concluded that fat surrounding the polyp (which incidentally was small in size) led to an erroneous diagnosis. Small bowel ischemia represents the third commonest diagnosis in our study. Out of 11 cases of ischemia, preop MDCT showed bowel ischemia with gangrene in 10 patients. Surgery and histopathology revealed bowel gangrene in all 11 patients. In the 11th patient CT diagnosis was incomplete as only a partial superior mesenteric vein thrombosis with normal appearing bowel was reported. This patient underwent surgery 12 hours later and found to have bowel gangrene intraoperatively. Superior mesenteric artery thrombosis was the commonest cause of ischemia as seen in 5 out of 10 patients (50%). Our findings correlated with Wolf et al study that depicted that the common cause of mesenteric ischemia as SMA thrombo-embolism in approximately 50% of the cases.[14] MDCT with multiplanar reformats was helpful in identifying SMA thrombus in the main trunk and segmental branches. Balthazar study has shown that CT is 83 % sensitive and 93% with accuracy of 91 % in diagnosing strangulation.[11] Although a study from Mayo clinic by Sheedy et al in the year 2006 claimed a poor prospective interpretation sensitivity of CT for the diagnosis of small bowel ischemia (range 29.6% - 40.7%), in our study MDCT was helpful in diagnosing small bowel ischemia in all but one case. Sheedy et al concluded that decreased bowel wall enhancement and presence of small bowel faces sign were significantly associated with small bowel ischemia in patients who were found to have small bowel ischemia at surgery.[15] Although MDCT helps in diagnosing strangulation and absence of strangulation on CT does not rule out ischemia which was observed in one of our patients. Stricture of the small bowel accounts for the second highest incidence in our study with eleven patients (18.3%), MDCT correctly diagnosed strictures preoperatively in 10 cases. The patient in whom CT diagnosis could not be made had dilated small bowel loops with signs of obstruction. This patient had a prior history of appendicectomy, in view of which the cause of obstruction was thought to be adhesions. However, a stricture was identified on surgery which was found to be the cause of obstruction. All other cases (10 cases) presented as small bowel obstruction with CT findings of dilated proximal loops with zone of transition. Intraoperatively all patients had strictures. Histopathology was inflammatory stricture in all cases. MDCT helps in diagnosing the presence or absence of obstruction, the site, severity and its cause.[16] MDCT was helpful in identifying all patients with obstruction. CT Enteroclysis was performed in 11 patients and they helped in identifying the exact site and cause of obstruction. From the surgeons,

perspective MDCT enteroclysis with multiplanar reconstructions gives a clear picture about the site of disease.[16] They are also helpful in tumor detection with intra venous and neutral contrasts.[17] MDCT correctly identified small bowel obstruction including its site in all 32 patients. The cause of obstruction was identified correctly on CT in 30 out of 32 patients (93.7%). In one patient intussusception due a polyp was misdiagnosed as lipoma. In the second patient obstruction which was due to stricture was misdiagnosed as being due to adhesion. Non obstructive disease of small bowel was seen in 28 patients. Out of 28 cases, 23 patients, histopathology and intra op correlated with MDCT. In 4 patients which were reported as tuberculosis on MDCT, on histopathology correlation 2 patients were reported as having chronic inflammatory change, 1 patient had chronic lymphoid hyperplasia whereas 1 patient was finally diagnosed as having a Meckel's diverticulum with inflammation. In 1 patient only a partial thrombosis of superior mesenteric vein with a normal appearing bowel was reported on CT. Surgery and histopathology showed gangrene.

CONCLUSION

MDCT plays an extremely important role in diagnosing various small bowel pathologies. Both obstructive and non-obstructive lesions are evaluated well by MDCT. MDCT is extremely accurate in diagnosing the level, and cause of obstruction.

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