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Original Research Article

Diagnostic performance of contrast enhanced computed tomography in intestinal obstruction

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ABSTRACT

Introduction: Intestinal obstruction (IO) is a frequent cause of admission to the surgery and emergency departments. For the prevention of complications, such as ischemia and perforation, early recognition of IO is crucial. Computed tomography (CT) provides excellent details regarding cause, site & complications of IO and also helps in treatment planning.

Aim: To evaluate the efficacy and accuracy of CECT imaging in diagnosing IO and detecting complications. To correlate CECT findings with surgical or histopathological findings.

Materials and Methods: A prospective study was conducted in the Department of Radiology, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India for a period of 2 years from September 2020 to September 2022. Fifty patients with suspected intestinal obstruction were evaluated, after obtaining informed consent. Data was analysed using SPSS 22 version software.

Results: Male predominance was seen in this study, males constituted 58% and females 42%. The commonest age group affected was 41-50 years. Small bowel obstruction (SBO) was much more prevalent than large bowel obstruction (LBO). The most common site of BO was ileum. The leading cause of SBO was adhesions and in LBO was bowel malignancy.

Conclusion: IO is a fairly common presentation in clinical and radiological practice. There are various causes as well as mimickers of IO, which makes it a challenging task to accurately diagnose. CECT helps in treatment planning by providing information about bowel viability. We found it is extremely useful to include CECT study as a standard protocol in evaluation of patients presenting with bowel obstruction.

1. Introduction

Intestinal obstruction (IO) is a frequent cause of admission to the surgery and emergency departments. Early recognition of bowel obstruction (BO) is crucial for the prevention of consequences, such as ischemia and perforation.[1] Computed tomography (CT) has been established in prior research to be an effective imaging modality for intestinal obstruction.[1]

Bowel obstruction-related morbidity and mortality represent 12–16% of all surgical admissions and are significant. The most frequent cause of BO is postoperative adhesions which is seen in 70% of patients. Hernias, neoplasms, and Crohn's disease are some additional common causes. Mechanical obstruction of the large bowel occurs four to five times less frequently than obstruction of the small intestine.[2]

Initial investigations such as plain radiographs have been shown to have a low sensitivity and specificity and therefore have a limited role in assessment of bowel obstruction. They are also limited in their ability to accurately predict

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the site and cause of obstruction. Other studies, such as enteroclysis may be contraindicated in patients with complete bowel obstruction and in patients with suspected strangulation or perforation. Therefore, has limited use in patients with markedly diminished intestinal peristalsis.[3] Given that conventional film radiography in patients with intestinal obstruction symptoms tend to be less sensitive and specific, CT is crucial in the evaluation of bowel obstruction.

This study was conducted to assess the role of CECT (Contrast Enhanced Computed Tomography) in detecting etiology, diagnosis and treatment of intestinal obstruction. The CECT diagnosis was confirmed by intraoperatively findings or histopathological diagnosis.

2. Aim

To evaluate the efficacy and accuracy of CECT imaging in diagnosing intestinal obstruction and detecting complications. To correlate CECT findings with surgical or histopathological findings.

3. Materials and Methods

This prospective study was conducted in the tertiary care hospital of eastern India. Evaluation of fifty patients was done based on inclusion and exclusion criteria, after obtaining informed consent for a period of 2 years from September 2020 to September 2022.

3.1. Inclusion criteria

Patients with suspected intestinal obstruction and undergoing CECT abdomen followed by surgical or histopathological evaluation.

3.2. Exclusion criteria

Patients in whom CECT is contraindicated (pregnancy, renal failure, sensitivity to the iodinated contrast medium), patients with adynamic obstruction and in whom surgical or histopathological findings were not available.

3.3. Protocol

A detailed history of abdominal pain, vomiting, constipation or obstipation, abdominal distension, fever, loss of weight and any other related symptoms were taken. All patients underwent CECT of the abdomen by GE OPTIMA 64 slice MDCT and Medrad stellant double-barrel pressure injector.

First, NCCT scan of the abdomen was taken followed by Contrast enhanced CT scan of abdomen by intravenous administration of non-ionic iodinated contrast, Iopromide (1.5ml/kg body weight @ 1 – 1.5cc/sec). Next series of images were taken in venous phase with scan delay of 60-70 seconds. Oral or rectal contrast was not given. Only intravenous contrast was administered.

In cases of suspected mesenteric arterial occlusion, an early arterial phase (20-25 seconds scan delay) followed by venous phase (60-70 seconds scan delay) was performed using IV contrast at the rate of 3 - 4cc/second. The patients were followed up for the intra-operative or histopathological findings for correlation.

3.4. Statistical analysis

Data entered into Microsoft excel data sheet and analysed using SPSS 22 version software. Categorical data represented in the form of frequencies and proportions. Collected data were analysed by sensitivity, specificity, positive predictive value, negative predictive value and accuracy.

4. Results

In our study, intestinal obstruction was observed more frequently in males as compared with females (58% vs 42% respectively).

The male to female ratio in the current study is 1.3:1, which is comparable to previous studies. Whereas other studies like Adhikari S. et al. reported a male to female ratio of 4:1 in their study. Male to female ratio in the study by Osuigwe AN et al. was found to be 2:1.9.[4,5]

In our study the commonest age groups belonged to patients of age 41 to 50 years (n = 14; 28%) followed by 51 to 60 years (n = 12; 24%) and 31 to 40 years (n = 7; 14%).The age range of 21 to 30 years had the fewest patients (n = 2, or 4%). The mean age of the study group's patients was 49.5 years, with the youngest being 11 years old and the oldest being 84 years old.

The commonest presenting complaint in our study was pain abdomen, which was seen in all the patients followed by abdominal distension in 32 patients (64%), vomiting (n = 33; 66%), constipation/obstipation (n = 29; 58%) and lastly some of the patients showed weight loss, fever and rectal bleeding. Majority of the patients presented with multiple complaints. Constipation was primarily a complaint in patients with LBO and only small percentage of patients with SBO had constipation.

Data from various studies have also shown similar clinical complaints. Saini et al have reported pain abdomen in all the patients with bowel obstruction, abdominal distension in 82.5% of patients, vomiting in 67.5% of patients, followed by constipation/obstipation in 60% of patients, and abdominal tenderness in 65% of patients.[6]

In their study of 53 patients with intestinal obstruction, Singhania et al. found that 75.47% of patients had abdominal distension, 73.58% had constipation, 54.72% had vomiting, and 56.6% had abdominal discomfort.[7]

Previous history of abdominal surgery is crucial, though adhesions are the most frequent cause leading to intestinal obstruction. Other long term postoperative complications

which can lead to bowel obstruction include external hernias, internal hernias and anastomotic stricture. In our study, 15 patients out of 50 had operative history, out of the them 8 (44.44%) were diagnosed with adhesions and two cases of incisional hernia. Operative history of the above mentioned patients included hysterectomy, appendectomy, cholecystectomy, splenectomy and nephrectomy.[8–10]

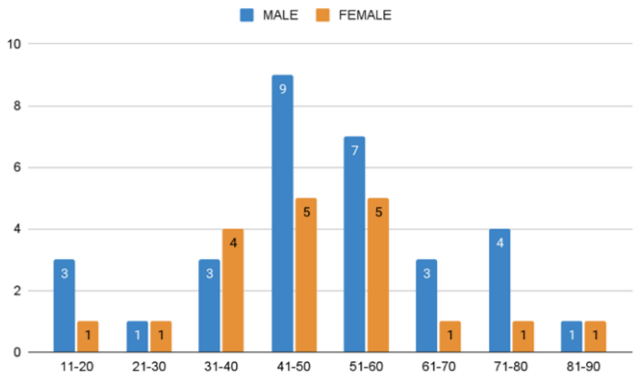

Figure 1: Age and sex distribution of patients

5. Discussion

Intestinal obstruction is an important differential diagnosis in patients with acute abdomen. Clinical diagnosis of intestinal obstruction can be challenging and imaging plays a significant role in diagnosis of intestinal obstruction. Currently, the CECT abdomen is thought to be the radiological investigation that is most suitable for evaluating suspected small and large intestine obstruction. A CT scan can show the degree of intestinal obstruction, identify the cause of frequent bowel obstruction, and distinguish between high- and low-grade obstruction. Additionally, CECT aids in evaluating obstruction-related complications like strangulation.[11]

In our study of 50 patients with suspected intestinal obstruction, we tried to describe the accuracy of CECT compared to the intraoperative or histopathological findings. Associated findings were also studied and have been mentioned in this section.

On CT there were 50 patients diagnosed with intestinal obstruction. However, surgical confirmation of intestinal obstruction was noted in 46 cases. The remaining four cases had no obstruction. CT was false positive in 8% cases. In false positive cases, 2 were diagnosed as adhesions, other was stricture due to TB and the remaining one was a case of hernia leading to obstruction. Though CT showed dilated bowel loops, intraoperatively no significant bowel obstruction was seen in these cases.

5.1. Level and site of obstruction

A total of 50 individuals with bowel obstruction were seen in our study, of which 37 (74%) had SBO and 13 (26%) had LBO. Ileum and ileocecal junction obstruction was most prevalent among SBO which was seen in 29 patients (58%). The sigmoid colon was the most frequent location of obstruction in LBO patients, accounting for 12% of total cases, followed by the transverse colon (6%). LBO at descending colon and rectum was observed in 2%.

Our study finding is consistent with Mohi JK et al, Singh A et al and Sekhon G et al, which reported that small bowel obstruction was much more commoner compared to large bowel obstruction.[5,12–14]

5.2. Associated findings

The commonest findings observed on CT in our study were presence of dilated bowel loops in all patients followed by ascites in 23 patients (46%) bowel ischemia in four patients (8%). Pneumoperitoneum was seen in a case of diaphragmatic hernia due to bowel perforation. Other less common findings were presence of lymph nodes, strangulation, gangrene, mesenteric haziness and obliterated mesenteric vessels.

In our investigation, five patients (10%) with high grade intestinal obstruction displayed the "small bowel feces" sign. Due to its proximity to the obstruction or transition point, this sign is significant since it aids in locating the transition point in intestinal obstruction.[15–19]

In 5% of patients, Singhania et al. reported, the "small bowel faeces" sign was present.43 Lazarus et al reported a high incidence of small bowel faeces sign in their study (n = 19 of 34 patients; 55.9%) in patients with SBO only.[16]

In their investigation, Lazarus et al. observed that individuals with SBO alone had a high ratio of small bowel faeces sign (n = 19 of 34 patients; 55.9%). They had a disproportionately high number of moderate and high grade obstruction in their study, which likely accounts for the study's exceptionally high incidence of "small bowel faeces" sign.[16]

5.3. Cause of obstruction

In this study, adhesions are commonest cause of bowel obstruction. 36% of patients had obstruction due to adhesions. Out of 18 patients diagnosed with adhesions, 8(44.44%) of them had previous history of abdominal surgery. Diagnosis of adhesions is challenging as adhesive bands are not directly visualized on CT. On surgery, it was found that two patients with adhesions identified on a CT scan had no signs of intestinal obstruction.

Adhesions are the most prevalent cause of bowel obstruction which in concordance with many other previous studies.[12] However, studies by Elsayed EE, Mohi JK et al, Sindhwani et al showed the commonest cause of obstruction

Table 1: Clinical presentation of patients

Symptoms	Number of patients	Percentage
Pain abdomen	50	100
Abdominal distension	32	64
Vomiting	33	66
Constipation	29	58
Others	11	22

Table 2: Cause of bowel obstruction

Etiology	Number of patients	Percentage
Volvulus	4	8
Koch's abdomen	5	10
Carcinoma colon	5	10
Adhesion band	18	36
Stricture	3	6
Obstructed hernia	11	22
Inflammatory	2	4
Intussuscpetion	2	4

Table 3: Site of bowel obstruction

Site of obstruction	Number of patients	Percentage
Duodenum	0	0
Jejunum	9	18
Ileum & ileocaecal junction	29	58
Caecum & ascending colon	1	2
Transverse colon	3	6
Descending colon	1	2
Sigmoid colon	6	12
Rectosigmoid junction & rectum	1	2

Table 4: Associated CECT findings in bowel obstruction

CT signs	Number of patients	Percentage
Free fluid	23	46
Vascular compromise	4	8
Perforation	1	2
Free air	1	2
Lymph nodes	12	24
Small bowel feces sign	5	10

Table 5: Diagnostic values of CECT in diagnosing cause of intestinal obstruction

	Sensitivity	Specificity	PPV	NPV	Accuracy
Intussusception	100%	100%	100%	100%	100%
Adhesion	83.33%	96.88%	93.75%	91.18%	92%
Inflammatory	100%	97.96%	50%	100%	98%
Carcinoma colon	100%	100%	100%	100%	100%
Stricture	66.67%	97.87%	66.67%	97.87%	97.87%
Hernia	100%	97.50%	90.91%	100%	98%
Volvulus	100%	100%	100%	100%	100%
TB	100%	97.83%	80%	100%	98%

Table 6: Diagnostic values of CECT in diagnosing presence of intestinal obstruction

	Sensitivity	Specificity	PPV	NPV	Accuracy
Intussusception	100%	100%	100%	100%	100%
Adhesion	100%	94.12%	88.89%	100%	96%
Inflammatory	100%	97.96%	50%	100%	98%
Carcinoma colon	100%	100%	100%	100%	100%
Stricture	100%	97.87%	100%	100%	100%
Hernia	100%	97.50%	90.91%	100%	98%
Volvulus	100%	100%	100%	100%	100%
TB	100%	97.83%	80%	100%	98%

to be malignancy.[4,5,20] The native patient population and the illness demography could be the reason accountable for the variance in the results.

The second most common cause was obstructed hernia accounting for 22%. There were eleven cases of hernia which included incisional hernia, diaphragmatic hernia, ventral hernia, inguinal and inguino scrotal hernia. Three of them had gangrenous bowel loops which were correctly diagnosed on CECT. There was a case of incisional hernia with bowel adhesion with gangrenous bowel loops, though gangrene was diagnosed on CECT, adhesion was undiagnosed.

Most common cause of large bowel obstruction was found to be neoplasia in our study. There were five cases of carcinoma colon leading to bowel obstruction. Three cases of carcinoma colon affecting sigmoid colon were observed. One of them was seen affecting descending colon and the other case was involving rectum. CT can accurately stage the malignancy. Additionally, extra luminal pathology can be well evaluated, making CT the preferred imaging modality.[21]

Five cases of abdominal tuberculosis were noted. Most of them were associated with multiple enlarged lymph nodes. One of them had coexisting pulmonary tuberculosis. Three of the patients had adhesions and strictures leading to high grade obstruction, who were treated surgically. One of the patients diagnosed with intestinal obstruction was found to have no significant obstruction intraoperatively.

In our study, there were four cases of intestinal volvulus, two each in small and large bowel. Two cases affected the sigmoid colon. One of them had associated bowel ischemia. There were two cases of midgut volvulus with associated malrotation of gut. Volvulus is a broad term describing twisting of colon around its mesentery. Torsion causes luminal narrowing at the point of twisting and leads to vascular compromise. Bowel ischemia and perforation are serious complications associated with volvulus. CECT can give surgeon crucial information regarding presence of strangulation, which determines the further line of management.[21]

There were three cases of stricture. Two of them were malignant strictures affecting the large bowel. One case which was diagnosed to be stricture was found to be dense fibrotic bands surrounding the terminal ileum intraoperatively. The patient had a prior history of appendectomy.

There were two cases of obstruction of inflammatory origin. One patient was diagnosed with distal ileal stricture, who was operated and found to have associated Meckel's diverticulitis with oedema. Another case was diagnosed to have terminal ileal stricture with bowel ischemia, which was found to be gangrenous bowel loops due to band adhesion. Other cases of obstruction were due to intussusception with lipoma as lead point in our study, which were correctly diagnosed on CT.

There were 2 cases of adhesions which were wrongly identified as stricture on CT scan. Another case diagnosed as inflammatory bowel wall thickening with obstruction turned out be adhesion in surgery. Lastly, there was a case of obstructed hernia diagnosed on CT. There was associated adhesion found intraoperatively, which was not picked up on CT scan. Diagnosis of adhesions is tough, as not always they are visualized on CT.

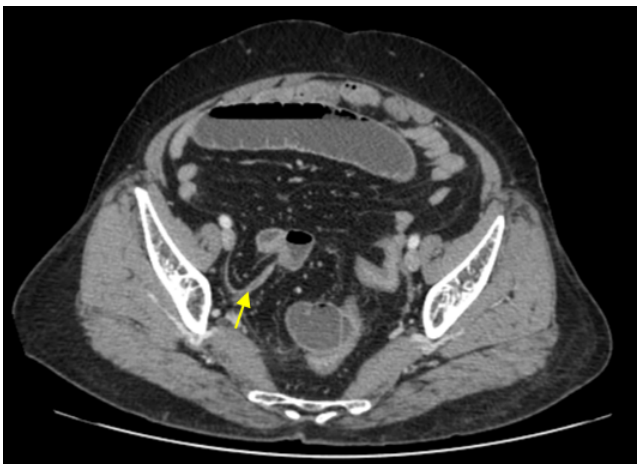

Figure 2: A 48-year-old female came with complaints of abdominal pain and nausea persisting since few months. She had prior history of hysterectomy. The case was diagnosed to be adhesions leading to intestinal obstruction.

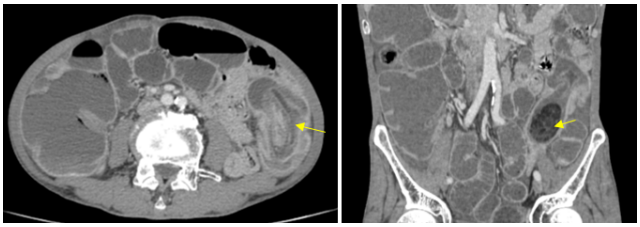

Figure 3: A 74-year-old male came complaints of abdominal pain and constipation since a week.Axial CTof the abdomen shows the presence of a bowel-within-bowel configuration, characteristic for intussusception. Coronal reformatted image shows lipoma as the lead point for colo-colic intussusception with proximal bowel dilatation

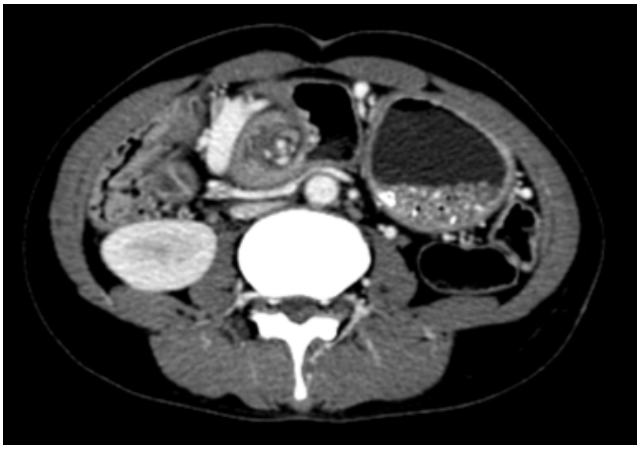

Figure 4: A 32-year-old female presented with abdominal pain and vomiting since 4 days. CECT abdomen revealed twisting of mesentery with dilated proximal bowel loops suggestive of midgut volvulus with bowel obstruction.

5.4. Complications

Complications due to bowel obstruction include bowel ischemia leading to necrosis, perforation and peritonitis may even lead to death, if not managed appropriately in time. Four patients had complications in our study, out of which 3 were in patients with hernia. Complications were seen in 8% of total patients, which is comparable to previous studies which range from 7.5% to 12.5%.[5,21]

5.5. Diagnostic performance of CECT

Overall sensitivity, specificity, PPV, NPV, and accuracy values for CT in diagnosing intestinal obstruction in our study was 100%, 98.4%, 88.7%, 100% and 98.75% respectively. Pongpornsup S et al. in their study of 35 patients with SBO. The authors reported that CT had diagnosed 25 cases of SBO of which one was false positive. Overall SBO sensitivity, specificity, PPV, NPV, and accuracy values for CT were reported by the authors to be 96%, 100%, 100%, 90%, and 97%, respectively.[22]

Filippone et al reported a 94% accuracy rate for the CT-based diagnosis of bowel obstruction. The authors showed that coronal reformations boosted the accuracy of an axial CT scan in diagnosing SBO (88% versus 94% in axial and axial with coronal reformations, respectively). Furthermore, they claimed that when compared to the final diagnosis, axial sections alone outperformed coronal reformations alone in identifying SBO (92% vs. 82%, respectively). Furthermore, according to the authors, the accuracy of LBO diagnosis has improved (88% against 92% in axial and axial with coronal reformations, respectively).[23]

Other research, however, has revealed that CT has a reduced diagnostic efficacy for intestinal obstruction. 81.13% of SBO patients were successfully detected by CT, according to Singhania et al. The reported sensitivity and specificity with CT are 97.29% and 63.63%, respectively. 43 patients in their sample of 53 patients had intestinal obstruction diagnosed on CT, although the final diagnosis only identified 37 cases of bowel obstruction.[24]

In a review, Mallo et al. stated that the sensitivity, specificity, PPV, and NPV of CT for the diagnosis of SBO ranged from 81 to 100%, 84 to 100%, and 68 to 100%, respectively which is similar with our study.[25,26]

Studies with poorer sensitivity and specificity can have an inherent selection bias towards certain populations. If there are disproportionately more patients with low grade obstruction in the research population, CT may perform poorer. This is supported by data from Pongpornsup et al., who showed that CT could accurately identify only 58% of low grade SBO instances while being able to detect all cases of high grade obstruction.[22] The majority of the cases in our study were likely high grade obstruction, for which CT had great sensitivity and specificity.

The native patient population and the illness demography could be the reason accountable for the variance in the results.

6. Limitations

Patient population was limited and a more extensive patient population could have shown other factors causing bowel obstruction. Patients treated conservatively are not included. This could theoretically affect the overall accuracy of CT in evaluation of bowel obstruction. It is possible that the majority of patients who present with intestinal obstruction have suspected high grade obstruction only underwent surgical management and may not reflect the general population.

7. Conclusion

Intestinal obstruction is a fairly common presentation in clinical and radiological practice. There are various causes as well as mimickers of intestinal obstruction, which makes it a challenging task to accurately diagnose. In our

study of 50 cases of intestinal obstruction, CECT provided accurate information about the level of obstruction and underlying cause in most of the cases, except in two cases of strictures which were found to be adhesions on surgery, a case of hernia with bowel obstruction which had associated adhesion which was undiagnosed on CT, lastly a case of inflammatory stricture was found to be adhesion intraoperatively. CECT also provided information about the viability of affected bowel tissue, thereby helped in treatment planning. We found it is extremely useful to include CECT study as a standard protocol in evaluation of patients presenting with bowel obstruction.

8. Source of Funding

None.

9. Conflict of Interest

None.

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