

## Original Research Article

# Evaluation of imaging by radiography, ultrasonography and computed tomography in suspected cases of intestinal obstruction and its comparison with operative findings

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## ABSTRACT

**Background:** Intestinal obstruction is a common surgical emergency, accounting for up to 20% of acute abdominal surgeries. Rapid diagnosis is essential to prevent complications like ischemia, gangrene, and perforation. Imaging modalities play a critical role in identifying the site, cause, and severity of obstruction. The objectives of the study were to evaluate and compare the diagnostic accuracy of abdominal radiography, ultrasonography (USG), and computed tomography (CT) in detecting intestinal obstruction and its cause with intraoperative findings.

**Methods:** This prospective diagnostic evaluation study was conducted over 10 months in the department of radiodiagnosis at a private medical college in Thrissur. A total of 40 adult patients clinically suspected of intestinal obstruction who underwent radiograph, USG, CT, and subsequent surgery were included. Imaging findings were compared with intraoperative diagnoses. Statistical analysis was done using Chi-square and Fisher's exact tests.

**Results:** Among 40 participants, 82.5% were over 40 years and 57.5% were males. CT showed the highest sensitivity (100%) and NPV (100%) in detecting the cause of obstruction, while USG had good sensitivity (72.7%) and specificity (88.9%). Radiography showed low sensitivity (0%) but high specificity (100%). CT identified transition points in 95% of cases and the underlying cause in 70%, outperforming USG and radiography. Intraoperatively, adhesions (45%) and lesions (55%) were the common etiologies.

**Conclusions:** CT is the most accurate modality for diagnosing intestinal obstruction. While radiography remains useful for initial assessment, combining it with USG and CT improves diagnostic accuracy and guides timely surgical intervention.

**Keywords:** Abdominal radiograph, Computed tomography, Intestinal obstruction, Ultrasonography

## INTRODUCTION

Intestinal obstruction is a frequent medical issue that shares symptoms with many other urgent abdominal problems. It accounts for roughly one in five emergency surgeries for acute abdominal conditions.<sup>1,2</sup> It can be

physical (mechanical) or paralytic, and can occur in either the large or small intestine. The small intestine is the site of obstruction in the majority of cases, between 60% and 80%.<sup>2</sup> It has been a long-standing major surgical emergency, resulting in significant patient hardship and financial strain. Although the causes have evolved in

recent decades due to lifestyle and dietary shifts, with now adhesions predominating as the cause, followed by hernias and malignancies.<sup>3</sup>

Symptoms of intestinal obstruction vary, but abdominal pain, vomiting, distension, and constipation are common. Determining the appropriate treatment conservative or surgical demands careful assessment of clinical presentation alongside lab and imaging findings.<sup>4</sup> Timely surgical intervention is critical for acute obstructions from physical causes, closed loops, or complications such as strangulation or perforation. A significant challenge lies in the late diagnosis of strangulation, often only detectable after gangrene has developed.<sup>5</sup> The management of bowel obstruction has undergone a significant transformation over the last two decades. This shift is largely attributed to revolutionary developments in abdominal imaging, which have become the primary tool for clinical decision-making.<sup>6</sup>

Diagnostic imaging is now responsible for confirming the obstruction and providing comprehensive insights into its location, severity, potential causes, and complications.<sup>7</sup> Radiological imaging helps determine if a patient with small bowel obstruction should receive conservative treatment or undergo immediate surgery due to the risk of strangulation. Despite having limited diagnostic accuracy, with sensitivity and specificity in the 46-69% and 57-67% ranges respectively, plain abdominal radiography remains the initial imaging method for intestinal obstruction due to its ease of access, low cost, and availability even in less equipped medical facilities.<sup>8</sup> In the diagnosis of bowel obstruction, CT scans have proven to be invaluable, demonstrating high diagnostic accuracy. Beyond confirming the obstruction, CT provides critical information regarding conditions requiring immediate surgical intervention, such as closed loop obstruction and pneumatosis intestinalis. This study aimed to evaluate the effectiveness of different imaging techniques in determining the location, cause, and extent of bowel obstruction, and to compare these findings with what was observed during surgery.

## METHODS

This cross-sectional study was conducted over a period of 10 months from 1<sup>st</sup> August 2024 to 31<sup>st</sup> May 2025 following clearance from the ethics committee. The study was carried out in the department of radiodiagnosis at Private Medical College, Thrissur. Patients fulfilling the eligibility criteria were enrolled consecutively until the required sample size was obtained. The sample size was calculated based on the sensitivity of various imaging modalities- plain abdominal radiograph, ultrasonography (USG), and computed tomography (CT)- as observed in a previous study by Suri et al.<sup>9</sup> Using a 95% confidence level and 20% relative allowable error, the minimum sample size was estimated to be 40 based on the formula  $n = (z_{1-\alpha/2})^2 \times SN(1-SN) / l^2 \times P$ , with  $z_{1-\alpha/2} = 1.96$ , SN

= 77%,  $l = 20\%$  of SN, and  $p =$  proportion of intestinal obstruction cases.

The study population included all patients presenting to the emergency department or outpatient department with symptoms suggestive of intestinal obstruction who satisfied the inclusion criteria. Inclusion criteria were patients above 18 years of age with clinical suspicion of intestinal obstruction who underwent all three imaging modalities and surgical management. Patients who were not willing to participate, those with contrast allergy, pregnant women, and patients with debilitating diseases were excluded.

Eligible patients were enrolled after obtaining informed consent. Based on the treating physician's requisition, each patient underwent all three imaging modalities: erect/supine abdominal radiograph, ultrasonography, and CT scan. Radiographs were obtained using computed or digital radiography systems. USG was performed using both curvilinear and linear array transducers, with observations made regarding the possible site, level of obstruction, and associated findings. CT scans included pre-contrast imaging of the abdomen and pelvis followed by contrast-enhanced scanning after administering 1-2 ml/kg of iodinated contrast (iohexol-300 mg) intravenously. A 128-slice Optima G660 CT scanner was used to obtain contiguous axial sections of 0.625 mm. Axial, sagittal, and coronal reformatted images were generated, and additional imaging protocols such as maximum intensity projection and 3D reconstruction were applied as needed. CT findings were assessed for dilated bowel loops, air-fluid levels, level and degree of obstruction, and underlying cause. These imaging results were then compared with intraoperative findings.

The main outcome measured was the diagnostic accuracy of each imaging modality- radiograph, USG, and CT- in identifying the cause and features of intestinal obstruction, as confirmed by surgical findings. Quantitative data were expressed as mean and standard deviation, while categorical data were presented as frequency and percentage. Statistical analysis included tests of significance such as the Chi-square test and Fisher's exact test, wherever applicable. P value less than 0.05 was considered statistically significant.

## RESULTS

Among the study participants, the majority (33 individuals, 82.5%) were above 40 years of age, while 7 participants (17.5%) were below 40 years. In terms of gender distribution, 23 participants (57.5%) were male and 17 (42.5%) were females.

On abdominal radiograph evaluation among study participants, air-filled loops were observed in 19 (47.5%) cases, while air-fluid levels were seen in 18 (45%) and no abnormal gas pattern in 3 (7.5%). Small bowel diameter  $\geq 2.5$  cm was noted in 29 (72.5%) participants, large

bowel  $\geq 6$  cm in 7 (17.5%), and neither in 4 (10%). Valvulae/featureless loops were seen in 28 (70%) cases, while haustrations and absence of any radiographic pattern were each found in 6 (15%) cases. The dilated bowel was localized to the upper and mid abdomen in 21

(52.5%), lower and pelvis in 14 (35%), and periphery of the abdomen in 5 (12.5%). Air under the diaphragm was present in 4 (10%) and absent in 36 (90%) cases (Table 1).

**Table 1: Abdominal radiograph findings among study participants.**

Parameters	Categories	Frequency	Percentage
Air fluid/gas patterns	Air filled loops	19	47.5
	Air fluid levels	18	45.0
	None	3	7.5
Diameter of bowel	Small bowel $\geq 2.5$ cm	29	72.5
	Large bowel $\geq 6$ cm	7	17.5
	Neither	4	10.0
Radiographic pattern	Valvulae/featureless loops	28	70.0
	Haustrations	6	15.0
	None	6	15.0
Localization of dilated bowel	Upper and mid abdominal	21	52.5
	Lower and pelvis	14	35.0
	Periphery of abdomen	5	12.5
Air under diaphragm	Present	4	10.0
	Absent	36	90.0

**Table 2: Ultrasonographic findings among study participants.**

Parameters	Categories	Frequency	Percentage
Bowel diameter	$\geq 3$ cm	29	72.5
	$>6$ cm	3	7.5
	Both	8	20.0
Peristalsis	Present	36	90.0
	Absent	4	10.0
Location of dilated loops	Upper and mid abdominal	24	60.0
	Lower and pelvis	11	27.5
	Periphery of abdomen	5	12.5
Free fluid	Present	18	45.0
	Absent	22	55.0
Vascularity	Present	33	82.5
	Absent	7	17.5
Cause/lesion detected	Present	18	45.0
	Absent	22	55.0

On ultrasonographic evaluation, bowel diameter  $\geq 3$  cm was seen in 29 (72.5%) participants,  $>6$  cm in 3 (7.5%), and both measurements in 8 (20%). Peristalsis was present in 36 (90%) and absent in 4 (10%) cases. Dilated loops were located in the upper and mid abdomen in 24 (60%), lower and pelvis in 11 (27.5%), and periphery in 5 (12.5%). Free fluid was detected in 18 (45%) participants, while 22 (55%) had none. Vascularity was present in 33 (82.5%) and absent in 7 (17.5%). A causative lesion was detected in 18 (45%) and absent in 22 (55%) cases (Table 2).

On computed tomography, collapsed loops or calibre difference was observed in 35 (87.5%) participants.

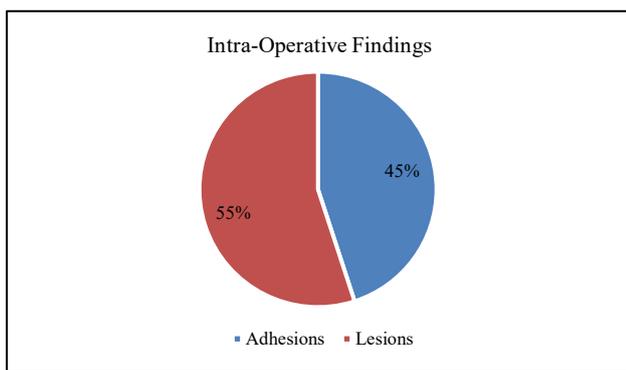
Bowel diameter  $>3$  cm was seen in 28 (70%),  $>6$  cm in 3 (7.5%), and both in 9 (22.5%). The small bowel feces sign was present in 16 (40%) cases. Bowel wall thickening or gangrene was noted in 19 (47.5%) participants. A transition point with angulation was identified in 38 (95%), while 2 (5%) had no such finding. Pneumoperitoneum was present in 8 (20%) cases and absent in 32 (80%). A definitive cause of obstruction was identified in 28 (70%) participants and not identified in 12 (30%) (Table 3). Intraoperative findings revealed that adhesions were the cause of obstruction in 18 (45%) participants, while lesions were identified in 22 (55%) cases (Figure 1).

**Table 3: Computed tomography findings among study participants.**

Parameters	Categories	Frequency	Percentage
Collapsed loops/calibre difference	Present	35	87.5
	Absent	5	12.5
Bowel diameter	>3 cm	28	70.0
	>6 cm	3	7.5
	Both	9	22.5
Small bowel faeces sign	Present	16	40.0
	Absent	24	60.0
Bowel wall thickening/gangrene	Present	19	47.5
	Absent	21	52.5
Transition point with angulation	Present	38	95.0
	Absent	2	5.0
Pneumoperitoneum	Present	8	20.0
	Absent	32	80.0
Cause of obstruction identified	Present	28	70.0
	Absent	12	30.0

**Table 4: Comparison of diagnostic accuracy of imaging modalities for detecting cause of bowel obstruction with intraoperative findings.**

Modality	Parameter assessed	Lesions detected	Adhesions detected	Sensitivity (%)	Specificity (%)
Ultrasonography	Lesion present	16	2	72.7	88.9
	Lesion absent	6	16		
CT abdomen	Lesion present	22	6	100	66.7
	Lesion absent	0	12		



**Figure 1: Intra-operative findings of cause of bowel obstruction among study participants.**

In patients with adhesions (n=18), ultrasonography showed bowel diameter  $\geq 3$  cm in 16 cases,  $>6$  cm in 2 cases, and none had both. In contrast, among patients with lesions (n=22), 13 had diameter  $\geq 3$  cm, 1 had  $>6$  cm alone, and 8 had both  $\geq 3$  and  $>6$  cm (p=0.005), indicating a statistically significant difference. On CT imaging, in the adhesion group, 16 had bowel diameter  $>3$  cm, 1 had  $>6$  cm, and 1 had both. In the lesion group, 12 had  $>3$  cm, 2 had  $>6$  cm, and 8 had both (p=0.037), also showing a significant association. For lesion detection, ultrasonography identified lesions in only 2 of the adhesion cases versus 16 in the lesion group, while

missing lesions in 16 adhesion and 6 lesion cases (p<0.001), showing a highly significant difference. CT scan detected lesions in 6 adhesion cases and all 22 lesion cases, with no missed lesion in the lesion group (p=0.032), confirming better diagnostic accuracy of CT over USG in identifying lesion etiology. The radiograph showed 0% sensitivity and 0% positive predictive value (PPV), indicating it failed to detect the cause of bowel obstruction, though it had 100% specificity and a negative predictive value (NPV) of 45%. Ultrasound demonstrated good diagnostic performance, with a sensitivity of 72.7%, specificity of 88.9%, PPV of 88.9%, and NPV of 72.7%, indicating it was fairly reliable in detecting and ruling out causes of obstruction. CT scan had the highest sensitivity at 100%, meaning it detected all true cases of obstruction causes. It also showed an NPV of 100%, a PPV of 78.6%, and specificity of 66.7%, confirming its superior overall accuracy in identifying the underlying cause when compared with intraoperative findings (Table 4).

**DISCUSSION**

The study provides insights into the radiographic, ultrasonographic, and CT findings in patients with suspected bowel obstruction. The analysis highlights key trends that have implications for diagnosis and management. The first imaging technique used in patients with bowel obstruction is usually radiography.

Nevertheless, the accuracy of evaluating the existence of obstruction and its causes with this modality is still low.

However, combining radiography and ultrasonography in patients with clinical suspicion improves the diagnostic predictability of intestinal obstruction. CT was advocated and can be used to determine the exact location and cause of obstruction.

In this study, the majority of the patient population (82.5%) were over 40 years old, while rest of them were 40 years or younger. These findings align with a study by Koşar et al, who reported that approximately 60% of patients were over 60 years old, indicating a skewed distribution. Similarly, a study conducted at GMC Patiala found that the highest number of patients presenting with intestinal obstruction were in the 41-50 age group. Additionally, males were more frequently affected than females.<sup>10</sup>

Within this analysis cases of bowel obstruction about 47.5% of the participants had air filled loops. And 45.0% had air fluid levels. There was absence of both patterns in 7.5% of study population. This observation aligns with previous studies by Thompson et al in which multiple air-fluid levels and air-filled loops are commonly observed on upright abdominal radiographs. The presence of air-fluid levels measuring 2.5 cm or wider, as well as unequal heights within the same loop, are significant indicators of SBO.<sup>11</sup>

During the course of the present study, it was demonstrated that around 70% of the participants had diameters corresponding to small bowel and 17.5% of the participants had dilated large bowel loops. It was uniform in all three imaging modalities and correlated positively with the intraoperative findings. 10.0% of the participants had no dilated bowel loops appreciable in abdominal radiograph, this however was appreciable with further imaging with sonography and CT. The above observed distribution is similar to the study by Catena et al in which findings indicated that small bowel obstructions (SBO) accounted for 55-75% of cases, while large bowel obstructions (LBO) accounted for 25-45%. This suggests that SBOs are more common than LBO.<sup>12</sup>

In this study ultrasound identified a cause/lesion in 45% of the patient population, a cause could not be detected in larger proportion (55%). Another study by Long et al indicated similar diagnostic accuracy of ultrasonography for SBO which might be lower when comparing with CT, it showed a sensitivity of 88% and specificity of 54%.<sup>13</sup> Majority (95%) of patients with intestinal obstruction exhibited transition point on CT, with only 5% showing none. This observation was similar to the study conducted by Colon et al involving 200 patients with intestinal obstruction found that 75% (150 patients) had a transition point identified on CT scans, while 25% (50 patients) did not.<sup>14</sup> The study demonstrated adhesions as the leading cause of bowel obstruction, identified in 43.0%. Followed

by carcinoma in 27.5% and hernia in 17.5% patients. Volvulus and intussusception were responsible for the obstruction in fewer than 12.0% patients each. Findings of this study parallel those by Bower et al, where adhesions was the major cause of obstruction, followed by malignancy and hernia.<sup>15</sup>

This study had certain limitations. The sample size was relatively small, with only 40 participants, which may limit the generalizability of the findings. Being a single-center study conducted in a private tertiary care hospital, the results may not be representative of broader or more diverse populations. Additionally, the study included only patients who underwent surgical intervention, potentially excluding milder cases managed conservatively and introducing selection bias. Operator dependency, especially in ultrasonography, may also have influenced the diagnostic accuracy, and interobserver variability was not assessed.

## CONCLUSION

This study underscores the critical role of multimodal imaging in the diagnosis and management of bowel obstruction, highlighting the complementary strengths of radiography, ultrasonography, and CT. While abdominal radiography remains the initial imaging modality, its limitations in sensitivity and specificity necessitate integration with ultrasound and CT for accurate diagnosis. CT emerges as the gold standard for identifying the location, cause, and complications of obstruction with a 95% detection rate for transition points and superior sensitivity for free air compared to radiography. Ultrasonography enhances diagnostic accuracy by detecting subtle bowel changes and ascites, particularly in cases where radiography is equivocal.

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