The Egyptian Journal of Hospital Medicine (October 2024) Vol. 97, Page 4403-4409

Role of Computed Tomography in Evaluation of Different Causes of Intestinal Obstruction Correlated with Operative Findings

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ABSTRACT

Background: Computed tomography (CT) is now widely used to diagnose intestinal obstruction. This is due to a significant shift in the approach to managing obstruction, resulting in a decline in the number of patients requiring surgical intervention.

Objective: The objective of this study was to assess the diagnostic accuracy of multi-detector computed tomography (MDCT) in detecting intestinal obstruction and determine the site, causes, and severity of the obstruction by comparing the results with intraoperative findings, which are considered the most reliable standard.

Patients and Methods: This study is a prospective cohort observational study that analyzed 80 patients who reported to the surgical emergency unit with symptoms of abdominal pain, abdominal distension, inability to pass feces and flatus. The patients included both males and females and were between the ages of 18 and 70 years. CT scans were performed and revealed intestinal dilatation, transition area between the dilated and collapsed loops and mesenteric fat stranding, The radiologist prepared the report based on surgical findings documented in operative notes that provided by the surgeon who performed the operation on the same patient.

Results: Regarding socio-demographic characteristics, the mean age of the studied patients was 49.54±16.34 years. Furthermore, 53(66.3%) if patients were males and 27(33.8%) of them were females. Intestinal adhesion, colorectal cancer, obstructed hernia were the commonest causes of IO final diagnosis detected 25(31.25%), 20(25%) and 12(15%) cases respectively. Assessment of diagnostic accuracy of multi-detector computed tomography scan in diagnosing intestinal adhesion, taking operative findings as a gold standard revealed that sensitivity was (98%), specificity (62.5%), positive predictive value (95.9%), and negative predictive value (83.3%).

Conclusions: MDCT is particularly essential in detecting many small bowel diseases. MDCT is effective in evaluating both obstructive and non-obstructive lesions. MDCT is highly accurate in determining the amount and source of blockage.

Keywords: Computed Tomography, Intestinal Obstruction, Operative Findings.

INTRODUCTION

Intestinal blockage is one of the most prevalent emergencies in general surgery, accounting for 15-20% of surgical admissions for acute abdominal pain and a substantial cause of morbidity and financial cost globally [1]. The occurrence of this condition is caused by either a physical obstruction or a malfunction that disrupts the usual flow of contents within a lumen. There are several known causes of mechanical bowel blockage, which, depending on where they occur, can be categorized as intrinsic, extrinsic, or intraluminal. Intraluminal causes (e.g., bezoars & fecal impaction), extrinsic causes (adhesions, closed loop, hernia, extrinsic masses (carcinoid tumors, lymphoma), and intrinsic causes (adenocarcinoma, Crohn's disease, TB, intussusception) are among the reasons [2]. The small bowel becomes implicated in situations of intestinal blockage, accounting for 60%-85% of occurrences [3, 4]. The most common cause of small bowel blockage is usually linked to external sources, such as adhesions and hernias. On the other hand, internal abnormalities including tumours or inflammation are the main causes of obstructions in the large intestine [5, 6].

Early detection of the underlying cause of intestinal blockage is critical in avoiding catastrophic consequences such as ischemia and gut necrosis [3, 7]. The diagnosis of intestinal obstruction is made after a thorough review of the patient's medical history, physical examination, and radiographic findings [8].

Radiological investigations encompass several techniques, including plain radiographs, contrast studies, and advanced imaging modalities like CT scans [9]. Plain radiographs exhibit a limited ability to accurately detect the existence of intestinal obstruction, with a sensitivity (69%), specificity (57%), and accuracy ranging from 46% to 80%. Furthermore, their accuracy in diagnosing the aetiology and location of the obstruction is considerably lower [6, 9].

Computed tomography (CT) is now widely used to diagnose intestinal blockage. This is due to a significant shift in the management of obstruction, resulting in a reduced number of patients requiring surgical intervention. Multi Detector Computed Tomography scanners offer significant improvements in performance, which can be utilized to decrease scan duration, decrease section collimation, or expand the length of scans during operation [9].

CT scans play an increasingly important role in diagnosing intestinal obstruction. They can determine the presence, severity, location, and cause of the obstruction, whether it is caused by external factors, internal factors, intussusception, or lesions within the

Received: 14/07/2024
Accepted: 15/09/2024

lumen of intestines. CT scans are also useful in identifying any associated strangulation. Additionally, CT scans can diagnose obstruction of the mesenteric vessels caused by thrombi by injecting contrast media intravenous, which can lead to a lack of movement in the intestines [10].

The aim of this work was to emphasize the role of the multidetector computed tomography (MDCT) in the evaluation of intestinal obstruction, the underlying causes, and the related conditions and then correlated with the operative findings.

PATIENTS AND METHODS

This prospective cohort observational study was conducted on 80 of patients after approval from the Ethical Committee at the surgical and radiological emergency unite, Sohag university hospital, Egypt. In the period From December 2021 to June 2022.

Inclusion criteria: Encompassed all patients who came to the surgical emergency unit with symptoms of intestinal obstruction, including abdominal pain, abdominal distension, and the inability to pass faeces or flatus. Patients of both sexes between the ages of 18 and 70 years.

Exclusion criteria: Pregnant females.

The data was collected from patients included their medical history, physical examination, and routine laboratory tests. They were then evaluated using advanced imaging technology, including the multi-slice CT scanners: Light speed 5X GE 8 detector elements scanner, GE Revolution Evo 128 multidetector elements scanner (made by GE Healthcare, Chicago, Illinois, USA), or Toshiba Alexion 16 detector elements scanner (Aplio 500, Toshiba Medical Systems, Otawara-shi, Tochigi 324-8550, Japan). Axial scans began 1cm above the diaphragm and ended at the lesser trochanters. Later, coronal and sagittal reconstruction pictures were acquired.

Generally, patients underwent oral preparation except for those who could not withstand oral preparation however they could receive IV contrast, patients received an intravenous injection of non-ionic contrast material and oral preparation. Iopromide was administered by an automated injector at a rate of 3 ml/s, based on body weight (1.5 ml/Kg). Others just received oral preparation based on renal function testing, such as those with hemodynamic instability, severe heart illness that causes orthopnea, sensitivity to the contrast medium, or chronic renal failure (or impairment) not receiving regular dialysis.

The criteria for intestinal obstruction were described using computed tomography: The small bowel is dilated to a diameter of 3 cm or more, whereas the colon is not dilated and has a diameter of less than 6 cm. There is a clear transition point between the dilated and non-dilated sections of the small bowel.

The existence of air-fluid levels indicates colon decompression, while a gasless abdomen indicates the presence of gas in the small bowel, which might result from vomiting. The String-of-beads sign is created by little gas pockets in a fluid-filled small bowel.

Management:

After proper evaluation of patients by (detailed history, clinical examination, laboratory investigation, CT), then patients transferred to emergency unit and different modalities of treatment were done according to possible etiology:

- Conservative treatment for patients with suspected adhesive IO with strict flow up.
- Laparoscopic management was the main line of treatment (diagnostic and therapeutic) either complete or laparoscopic assisted.
- Unstable patients and also patients with bad general conditions undergo open exploration from start.

Detailed Operative finding was recorded and then compare these data with preoperative CT finding. Operative, postoperative complications also was recorded.

Ethical approval: Approval was obtained from the ethical review committee of Sohag faculty of Medicine, (2020-0669-10376). Patients included in the trial provided informed and signed permission. The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

The statistical analysis was performed using SPSS version 26. The Shapiro-Wilks test and histograms were employed to assess the data's normal distribution. Quantitative variables were provided as mean± SD, median, and IQR. Qualitative variables were presented as frequency and percentage (%). The overall diagnostic performance was assessed by ROC curve analysis, the AUC evaluates the overall test. Sensitivity, specificity, PPV and NPV were determined. P-values were classified as extremely significant (<0.001), inconsequential (>0.05), and significant (<0.05) depending on their significance.

RESULTS

In a total of 80 patients age ranged from 18 to 70 years with mean a mean ± SD of 49.54 ± 16.34 years the majority of patients were males.

Table (1): Sociodemographic data of the studied patients

Age (Years)		**Range**	7-75	
		Mean ± SD	49.54±16.34	
		Median (IQR)	53 (23)	
			N	**%**
Gender	**Male**	**No (%)**	53	66.3
	Female	**No (%)**	27	33.8

Table (2): Distribution of the patients according to presenting symptoms

Presenting symptoms		N	%
History of previous abdominal operation	No	52	65
	Yes	28	35
Vomiting	No	5	6.3
	Yes	75	93.8
Abdominal pain	No	1	1.25
	Yes	79	98.75
Absolute constipation	No	3	3.75
	Yes	77	96.25
Abdominal distension	No	7	8.75
	Yes	73	91.25
Swelling at the scar site	No	77	96.25
	Yes	3	3.75
Tenderness at scar site	No	57	71.25
	Yes	23	28.75

The site of intestinal obstruction small intestine was in 66.25 %, large intestine 15 % and small and large intestine 18.75 %. Regarding the level of obstruction, 3.8 % patients had jejunal obstruction, 36.3 % patients had ileal obstruction, 18.8 % patients had jejunoileal obstruction, 25 % patients had colonic obstruction and 16.3 % patients had all the intestine obstructed. Regarding the vascular state, preserved blood supply 91.3 % while ischemia 8.8 % (Table 3).

Table (3): CT findings of the studied patients

CT findings		N	%
Intestinal obstruction	Small intestine	53	66.25
	Large intestine	12	15
	Small and large intestine	15	18.75
Level of obstruction	Jejunal	3	3.8
	Ileal	29	36.3
	Jejunoileal	15	18.8
	Colonic	20	25.0
	All the intestine	13	16.3
Vascular state	Preserved	73	91.3
	Ischemic	7	8.8

Regarding the CT diagnosis of the studied patients, 23 (28.75 %) patients had adhesions, 2 (2.5 %) patients had undetermined cause, 1 (1.25 %) patient had abscess, 21 (26.25 %) patients had a mass, 4 (5 %) patients had MVO, 2 (2.5 %) patients had intussusception, 1 (1.25 %) patient had Meckel's diverticulitis, 6 (7.5 %) patients had internal hernia, 12 (15 %) patients had complicated hernia, 3 (3.75 %) patients had gall stone ileus and 5 (3.75 %) patients had sigmoid volvulus, as shown in table (4).

Table (4): Distribution of the causes of intestinal obstruction

CT diagnosis	N	%
Adhesion	23	28.75
Undetermined cause	2	2.5
Intraperitoneal Abscess	1	1.25
Intestinal Mass	21	26.25
MVO	4	5
Intussusception	2	2.5
Meckel's diverticulitis	1	1.25
Internal hernia	6	7.5
Complicated external hernia	12	15
Gall stone ileus	3	3.75
Sigmoid volvulus	5	3.75

The site and histopathology of masses the study revealed that the most common site of mass was in rectosigmoid 6(30%) followed by descending colon 5 (25 %), as regard histopathology 3 cases of small intestinal neuroendocrinal tumor (13.04 %) and one ectopic pancreatic tissue (4.34%) (Table 5).

Table (5): Distribution of masses and their histopathology

	N	%
Site of the mass (n=20)		
Rectosigmoid	6	30
Sigmoid	1	5
Rectal	1	5
Hepatic flexure	1	5
Splenic flexure	2	10
Descending colon	5	25
Ileocecal	2	10
Transverse	2	10
Histopathology (n=23)		
Moderately differentiated adenocarcinoma	18	78.26
Poorly differentiated adenocarcinoma	2	8.69
Neuroendocrinal tumor	3	13.04
Ectopic pancreatic tissue	1	4.34

Table (6): Different modalities of treatment

Different modalities of treatment	N	%
Conservative treatment	24	30
Open exploration from the start	20	25
Laparoscopic treatment (Diagnostic & therapeutic)		
Complete laparoscopic procedure	14	17.5
Laparoscopic assisted management	19	23.75
Conversion rate	3	3.75

Intestinal adhesion, colorectal cancer, obstructed hernia were the commonest causes of IO final diagnosis detected 25(31.25%), 20(25%) and 12(15%) cases respectively.

Table (7): Distribution of diagnosis by CT and final diagnosis taking operative data as a gold standard

Distribution of diagnosis by CT	**N**	**%**
Misdiagnosis by CT	6	7.5
Correct diagnosis by CT	74	92.5
Final diagnosis (n=80)	**N**	**%**
Adhesion	25	31.25
Colorectal cancer	20	25
Obstructive hernia	12	15
Gall stone ileus	3	3.8
Sigmoid volvulus	5	6.3
Small intestinal tumor	2	2.5
MVO	4	5.0
Intussusception	2	2.5
Meckel's diverticulitis	1	1.3
IBD	1	1.3
Internal hernia	5	6.3

Agreement Sensitivity, specificity and diagnostic accuracy for Computed Tomography compared with final diagnosis. Colorectal cancer, final diagnosis detected 20 positive cases, CT detected 19 positive case and 1 missed case, that study could discriminate colorectal cancer with 95 % sensitivity, 100 % specificity, 100 % PPV and 98.4 % NPP. Obstructive hernia, final diagnosis detected 12 positive cases, CT detected the same cases.

CT could discriminate obstructive hernia with 100% sensitivity, 100% specificity, 100% PPV and 100% NPP. Mesenteric vascular occlusion (MVO), final diagnosis detected 4 positive cases, CT detected the same cases, while final diagnosis detected 76 negative cases and CT detected the same cases.

CT could discriminate mesenteric vascular occlusion with 100% sensitivity, 100% specificity, 100% PPV and 100% NPP. Intussusception, final diagnosis detected 2 positive cases, CT detected the same cases. CT could discriminate intussusception with 100% sensitivity, 100% specificity, 100% PPV and 100% NPP (Table 8).

Table (8): Diagnostic accuracy for computed tomography compared with final diagnosis

		Final diagnosis			**Sensitivity%**	**Specificity %**	**PPV%**	**NPV%**
		Positive	**Negative**	**Total**				
Adhesion	**Positive**	23	0	23	92%	100%	100%	96.5%
	Negative	2	55	57				
	Total	25	55	80				
Colorectal cancer	**Positive**	19	0	19	95%	100%	100%	98.4%
	Negative	1	60	61				
	Total	20	60	80				
Obstructive hernia	**Positive**	12	0	12	100%	100%	100%	100%
	Negative	0	68	68				
	Total	12	68	80				
Sigmoid volvulus	**Positive**	5	0	5	100%	100%	100%	100%
	Negative	0	75	75				
	Total	5	75	80				
MVO	**Positive**	4	0	4	100%	100%	100%	100%
	Negative	0	76	76				
	Total	4	76	80				
Intussusception	**Positive**	2	0	2	100%	100%	100%	100%
	Negative	0	78	78				
	Total	2	78	80				
Meckel's diverticulitis	**Positive**	1	0	1	100%	100%	100%	100%
	Negative	0	79	79				
	Total	1	79	80				
Internal hernia	**Positive**	5	1	6	100%	98.7%	83.30%	100%
	Negative	0	74	74				
	Total	5	75	80				

Cases (1): 18 years old male patient, presented by abdominal pain, absolute constipation and persistent vomiting with history of previous appendectomy 6 months ago. CT: revealed small bowel obstruction with transitional zone at RT iliac fossa region, suggestive site of adhesive band, as shown in figure (1)**.**

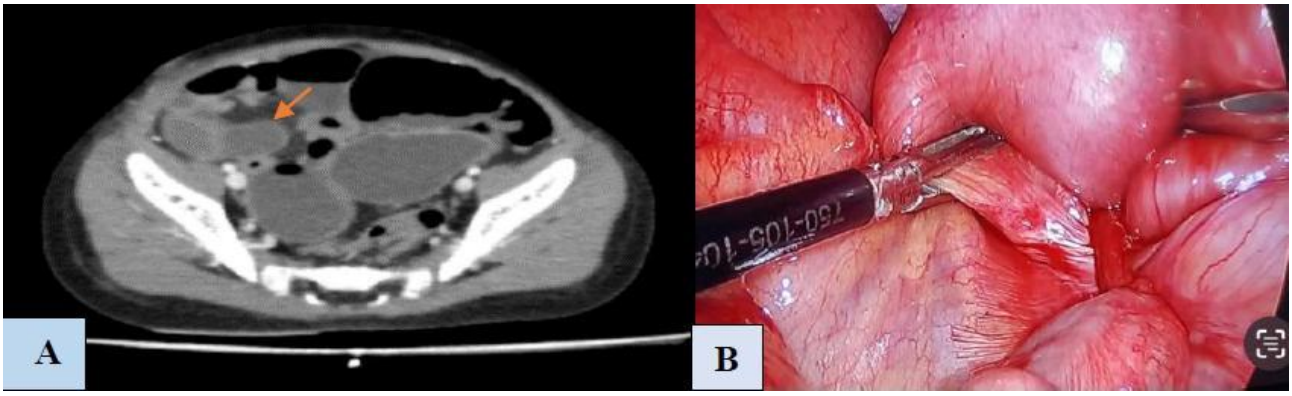

Figure (1): part (A) Axial view of enhancing CT Abdomen & pelvis shows small bowel obstruction with transitional zone (orange arrow) at RT iliac fossa region, suggestive site of adhesive band. **Part (B)** laparoscopic view of adhesive band.

Cases (2): 65 years old female patient, presented by abdominal pain, vomiting, absolute constipation and abdominal distension. CT reveled small and large bowel obstruction secondary to malignant colonic mass lesion.

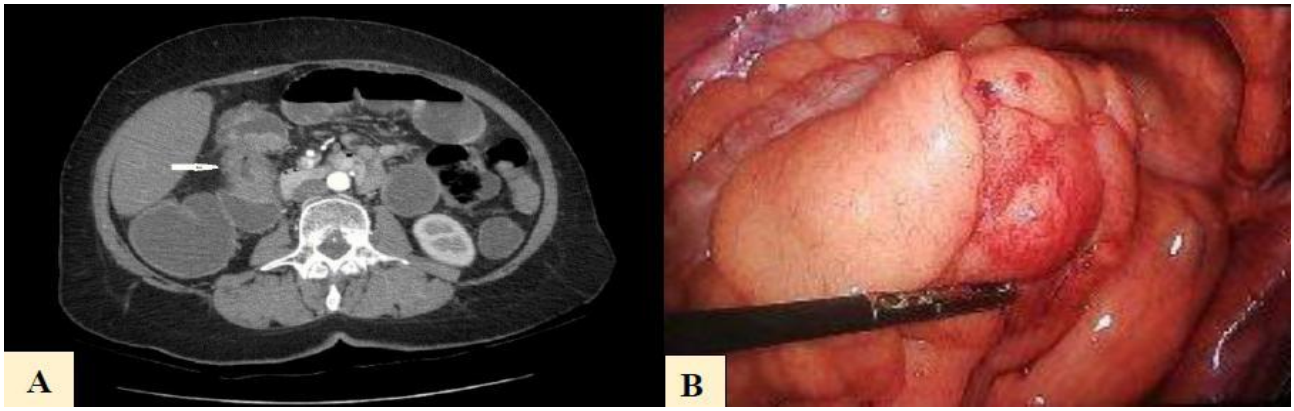

Figure (2): Part (A) Axial view of enhancing CT abdomen showed small and large bowel obstruction secondary to malignant featuring colonic mass (white arrow). **Part (B)** laparoscopic view of colonic mass lesion intraoperative.

Cases 3: 58 years old male patient, presented by abdominal pain, vomiting and abdominal distension. CT revealed small bowel obstruction secondary to intestinal mass of intussusception with small sized enhanced mass lesion. The apex of the mass) seen within.

Operative data: Resection and anastomosis of the mass was done sent to histopathology and proved that the mass was ectopic pancreatic tissue, as shown in **figure (3)**.

Figure (3): Enhanced CT abdomen axial view showed enhancing intraluminal mass lesion, the apex of intussusception (white arrow).

DISCUSSION

Approximately 15-20% of patients in the surgical emergency unit report with abdominal pain due to intestinal obstruction. This condition accounts for almost 20% of all emergency surgical procedures [11]. In order to avoid unnecessary surgical intervention with significant morbidity and mortality, it is important to identify patients whose intestinal obstruction can resolve spontaneously by conservative therapy [12].

One of the primary objectives of promptly diagnosing intestinal obstruction is to prevent consequences such as ischemia and gut necrosis [13]. The diagnosis of intestinal obstruction is often determined by evaluating the patient's medical history, clinical examination, and analysing radiographic findings. However, it is important to note that plain radiographs have been reported to exhibit low sensitivity, specificity, and accuracy, with literature citing values of 69%, 57%, and 46-80% correspondingly [14]. The use of MDCT has demonstrated a high level of accuracy in both detecting and confirming cases of small intestine obstruction. In addition, the MDCT can't only determine location of the obstruction, but it can determine the actual aetiology of the obstruction, as other studies have also found [15].

The study conducted by **Chuong *et al.* [13] and van Oudheusden *et al.* [16]** determined the accuracy of MDCT scan in identifying intestinal obstruction associated with sensitivity, specificity, positive predictive value and negative predictive value. The results showed that the sensitivity was 98.39%, specificity was 65.22%, positive predictive value was 93.85%, negative predictive value was 88.24% and diagnostic accuracy was 93.20%. The gold standard used for comparison was operative findings. Multiple studies have demonstrated the importance of computed tomography (CT) in accurately detecting intestinal obstruction, including determining the site, extent, and underlying cause. CT has shown a sensitivity ranging from 94% to 100% and an accuracy of 90% to 95% in this regard [13, 16]. The CT scan is highly effective in diagnosing small intestinal obstruction, with a sensitivity of up to 93% and a specificity of 100%, resulting in an accuracy rate of approximately 94% [16]. **Idris *et al.* [17]** discovered that MDCT was able to accurately identify 90% of cases with small bowel obstruction (SBO), but it failed to detect 10% of cases of transition. These results come in line with our results, regarding sensitivity, specificity, PPV & NPV of multidetector CT in diagnosis of intestinal obstruction were 98.6%, 62.5%, 95.9%, 83.3% respectively.

Regarding the site of intestinal obstruction small intestine was in 66.25%, large intestine was in 15 % and small and large intestine was in 18.75 %. Regarding the level of obstruction, 3.8% of patients had jejunal obstruction, 36.3% of patients had ileal obstruction, 18.8% of patients had jejunoileal obstruction, 25% of patients had colonic obstruction and 16.3% of patients had all the intestine obstructed. Regarding the vascular state, preserved blood supply was in 91.3 % while ischemia 8.8 %.

Regarding the CT diagnosis of the studied patients, 23 (28.75 %) patients had adhesions, 2 (2.5 %) patients had undetermined cause, 1 (1.25 %) patient had abscess, 21 (26.25 %) patients had a mass, 4 (5 %) patients had MVO, 2 (2.5 %) patients had intussusception, 1(1.25 %) patient had Meckel's diverticulitis, 6 (7.5 %) patients had internal hernia, 12 (15 %) patients had complicated hernia, 3 (3.75 %) patients had gall stone ileus and 5 (3.75 %) patients had sigmoid volvulus. Multiple studies are in line with our results as in **Carpeggiani *et al.* [18]** who showed that the most common cases were adhesive intestinal obstruction followed by colorectal cancers.

CT diagnosis correlated with final diagnosis (taking operative findings as gold standard), adhesive intestinal obstruction was the commonest cause as 25 positive cases were detected, CT detected 23 positive and missed 2 cases as transition point could not be detected due to marked dilatation of bowel loops, they were diagnosed as small bowel obstruction but cause of obstruction could not be clearly detected, while final diagnosis detected 55 negative cases and CT detected the same cases. CT could discriminate intestinal adhesions with 92% sensitivity, 100% specificity, 100% PPV and 96.5% NPP.

In 70.6% of patients and 52.9% of patients, respectively, the beak sign (defined by a beak-like constriction at the point of transition) and the fat notch sign (characterised by a central fatty indentation at the site of transition) are the most helpful of these signs. In contrast, four of them are controlled and enhanced in a conservative fashion. Moreover, **Prince and Weinreb [19]** conducted their multi–detector row CT studies in 159 patients with adhesive SBO that was initially treated medically were reviewed retrospectively.

In the current study, regarding colorectal cancer, final diagnosis detected 20 positive cases, CT detected 19 positive case and 1 missed case, that study could discriminate colorectal cancer with 95 % sensitivity, 100 % specificity, 100 % PPV and 98.4 % NPP. In agreement with our results **Porté *et al.* [20]** identified primary studies of CT colonography for surveillance of colorectal cancer patients. In the other side of the missed one case **Klang *et al.* [21]** showed that the rate is 48.8% higher than reported rates for CT misses in diagnosis of colorectal cancer. They found that a lack of fat stranding, vascular engorgement, or mesenteric lymphadenopathy contributed to the failure to diagnose colon tumours in certain patients. The average size of the tumours that were missed was 3.3 centimetres, whereas those that were found were 5.1 centimetres. Due to the short length of the stenotic segment in the rectosigmoid region, our analysis was unable to single out a single instance of this condition among the many cases of greatly enlarged, weakly enhanced bowel loops [21]. In our study, regarding obstructive hernia, final diagnosis detected 12 positive cases, CT detected the same cases. CT could

discriminate obstructive hernia with 100% sensitivity, 100% specificity, 100% PPV and 100% NPP. Harmonious to our results, **Li *et al.* [22]** observed that the pooled sensitivity and specificity for predicting surgical intervention were 87% and 73%, respectively. The accuracy for aetiology of adhesions, hernia and tumour was 95%, 70% and 82% respectively. In the present study, regarding mesenteric vascular occlusion, final diagnosis detected 4 positive cases, CT detected the same cases, while final diagnosis detected 76 negative cases and CT detected the same cases. CT could discriminate mesenteric vascular occlusion with 100% sensitivity, 100% specificity, 100% PPV and 100% NPP. On the base of ROC curves, **Brillantino *et al.* [23]** observed that CT diagnosis of vascular mesenteric ischemia, arterial, and non-occlusive small intestinal ischemia had an optimum cut-off value of 2.050.

In the present study, regarding intussusception, final diagnosis detected 2 positive cases, CT detected the same cases. CT could discriminate intussusception with 100% sensitivity, 100% specificity, 100% PPV and 100% NPP. Moreover, **Tan *et al.* [24]** showed that the area under the receiver operating characteristic curve for the risk score model in identifying intussusception. Area under curve (AUC) was 0.87 (95% CI: 0.81-0.93) when using the risk score.

CONCLUSION

MDCT played a crucial role in the diagnosis of numerous intestinal diseases. MDCT was highly accurate in detecting both obstructive and non-obstructive lesions, effectively evaluating the level and cause of obstruction. The multi-detector CT may be used consistently as a main modality for identifying intestinal blockage, resulting in effective and prompt care to reduce the morbidity and mortality of these specific patients.

Conflict of interest: None.
Financial disclosures: None.

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