ARAŞTIRMA / RESEARCH

Value of enhanced or non-enhanced computed tomography in the detection of rare causes of bowel obstruction

Bağırsak tıkanıklığının nadir nedenlerinin saptanmasında kontrastlı ve kontrastsız bilgisayarlı tomografinin değeri

Yasemin Altıntaş[1] (ID), Mehmet Bayrak[2] (ID), Ömer Alabaz[3] (ID)

[1]Ortadoğu Hospital, Radiologist, [2]General Surgeon, Adana, Turkey
[3]Cukurova University Faculty of Medicine, Departmand of General Surgery, Adana, Turkey

Abstract

Purpose: This study aims to reveal the uncommon causes of intestinal obstructions and to compare the diagnostic accuracy of enhanced or non-enhanced computed tomography.

Materials and Methods: This cohort was a retrospective study of different patients diagnosed with acute mechanical intestinal obstruction in the emergency room or hospital between 15 January 2009 and 15 June 2018. Exclusion criteria were common causes of mechanical bowel obstruction and inclusion criteria were uncommon causes of bowel obstruction. Non-enhanced or enhanced computed tomography were used to diagnose mechanical bowel obstruction.

Results: The population included 46 females and 41 males and the age range from 20 to 81. Of the patients with uncommon mechanical obstruction, 58 (66.7 %) were caused by the small intestine, and 29 (33.3%) by the large intestine. When compared to uncommon causes of the small and large bowel with age, body mass index, and use of contrast or not, no significant difference was detected between them. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of enhanced computed tomography were %93.9, %93.3, %96.9, %87.5, %94 and non-enhanced computed tomography were %96.0, %85.7, %92.3, %92.3, %92.3 respectively.

Conclusion: Non-enhanced computed tomography has similar diagnostic accuracy, sensitivity, and specificity compared to enhanced computed tomography for identifying the location, severity, and etiology of bowel obstruction.

Keywords:. Non-enhanced CT, enhanced CT, bowel obstruction

Öz

Amaç: Bu çalışma, bağırsak tıkanıklıklarının nadir nedenlerini ortaya koymayı ve kontrastlı veya kontrastsız bilgisayarlı tomografinin tanısal doğruluğunu karşılaştırmayı amaçlamaktadır.

Gereç ve Yöntem: 15 Ocak 2009 ve 15 Haziran 2018 tarihleri arasında, acil serviste veya hastanede akut mekanik bağırsak tıkanıklığı tanısı alan hastalar retrospektif olarak değerlendirildi. Veriler hasta dosyalarından ve görüntüleme sisteminden elde edildi. Mekanik bağırsak tıkanıklığı tanısı; muayene, klinik bulgular ve bilgisayarlı tomografi tetkikine dayanarak koyuldu.

Bulgular: Hastaların 46'sı kadın ve 41'i erkek ve yaş aralığı 20 ila 81 arasında idi. Mekanik tıkanıklığı olan hastalarda 58 (% 66.7) ince bağırsaktan ve 29 (% 33.3) kalın bağırsaktan kaynaklanmakta idi. Yaş, beden kitle indeksi ve kontrast kullanımı ile nadir görülen ince ve kalın barsak nedenleri karşılaştırıldığında, aralarında anlamlı bir fark saptanmadı. Altın standart cerrahi ile karşılaştırıldığında, kontrastlı veya kontrastsız bilgisayarlı tomografi bulgularının duyarlılık, özgüllük, pozitif prediktif değer, negatif prediktif değer ve tanısal doğruluğu sırası ile % 93,9, % 93.3, % 96.9, % 87.5, % 94 ve % 96.0, % 85.7, % 92.3, % 92.3, % 92.3 idi.

Sonuç: Kontrastsız bilgisayarlı tomografi, bağırsak tıkanıklığının yerini, şiddetini ve etiyolojisini tanımlamak için kontrastlı bilgisayarlı tomografi ile karşılaştırıldığında benzer bir tanısal doğruluk, duyarlılık ve özgüllüğe sahip olduğu saptanmıştır.

Anahtar kelimeler: Kontrastsız BT, kontrastlı BT, bağırsak tıkanıklığı

INTRODUCTION

Bowel obstruction (BO) is an abdominal emergency that causes significant morbidity and mortality, especially in acute complete obstruction and/or delayed diagnosis or treatment. There are notable differences in why small bowel obstruction (SBO) and large bowel obstruction (LBO) occur. Morbidity and mortality due to acute small bowel obstruction continue to be important. It corresponds to between 12 to 16% of operational applications in acute abdomen cases[1]. Most of the bowel obstruction is associated with postoperative adherences (~ 60%), hernias (15%), or tumors (15%) in the small intestine. More rare causes are inflammatory intestinal disease, trauma, intussusception, gallstones, foreign bodies, and endometriosis[2,3].

Although LBO is about five times less common than small intestinal obstruction and accounts for about 2-4% of all surgical entries[4]. Patients who had LBO representatively accompanied by abdominal ache, distension, and constipation[5]. Large bowel obstruction, high-grade small intestine obstruction, incarcerated and/or strangulated intestinal obstruction are usually treated by surgical intervention[6].

LBO can rarely occur acutely, as in cases of volvulus. Primary colon carcinoma is the utmost frequent reason of large bowel obstruction. Less frequent reasons for large bowel obstruction involve volvulus, diverticulitis, inflammatory intestinal disease, intestinal ischemia, fecal impaction, and other unusual and unfamiliar conditions[7,8]. Imaging plays a crucial role in the handling of BO by assigning the location, degree, and reason for obstruction, and also helps detect complications. The first radiographs are plain radiographs in the evaluation of patients with suspected bowel obstruction[8]. However, plain radiographs are diagnostic in 45-75% of cases with surgically approved bowel obstruction[9]. Computed tomography (CT) has been shown to have a higher accuracy rate both in diagnosing intestinal obstruction and in determining its cause and level[10].

CT is a progressively beneficial method in the assessment of intestinal diseases and also yields the diagnosis of non-intestinal disorders. Also, CT ensures a perfect evaluation of other abnormalities that often occur with intestinal diseases and increase specificity[11]. Whether CT provides the surgeon with the most important information is related to strangulation. It has been disclosed that the sensitivity of contrast-enhanced CT(ECT) to bowel ischemia is up to 90%[12].

There are studies on the evaluation of non-enhanced CT(N-ECT) in the diagnosis of renal colic[13,14]. For the assesment of patients who had acute right lower quadrant ache, several studies are showing that non-enhanced CT has a high diagnostic rate[15,16]. There are very few studies indicating the place of non-enhanced CT in intestinal obstruction [17].

This study aims to evaluate and compare the diagnostic accuracy of non-contrast and contrast-enhanced CT findings in patients with uncommon mechanical intestinal obstruction admitted to our clinic.

MATERIALS AND METHODS

This cohort was a retrospective study of various patients diagnosed with acute mechanical intestinal obstruction in the emergency room or hospital between 15 January 2009 and 15 June 2018. The Cukurova University Clinical Ethical Board approved the study which is a reference number of 94, 6 December 2019. All aspects of the study were performed according to the principles of the declaration of Helsinki (64th, 2013).

The study population consisted of 87 patients. Age and body mass index (BMI) were recorded from hospital data. Exclusion criteria were common causes of the small bowel (postoperative adhesion, hernias, tumors) and large bowel (carcinoma, postoperative adhesion, hernias) of mechanical bowel obstruction.

Inclusion criteria were uncommon causes of small bowel obstruction (Crohn disease, endometriosis, gastrointestinal stromal tumor, Meckel diverticulitis, intussusception, mesenteric ischemia, ischemic bowel, internal herniation, lymphoma, foreign bodies) and large bowel obstruction (volvulus(sigmoid), acute diverticulitis, ulcerative colitis, fecaloma, foreign bodies, Hirschsprung disease, ischemic bowel) were shown in the flowchart (Figure 1).
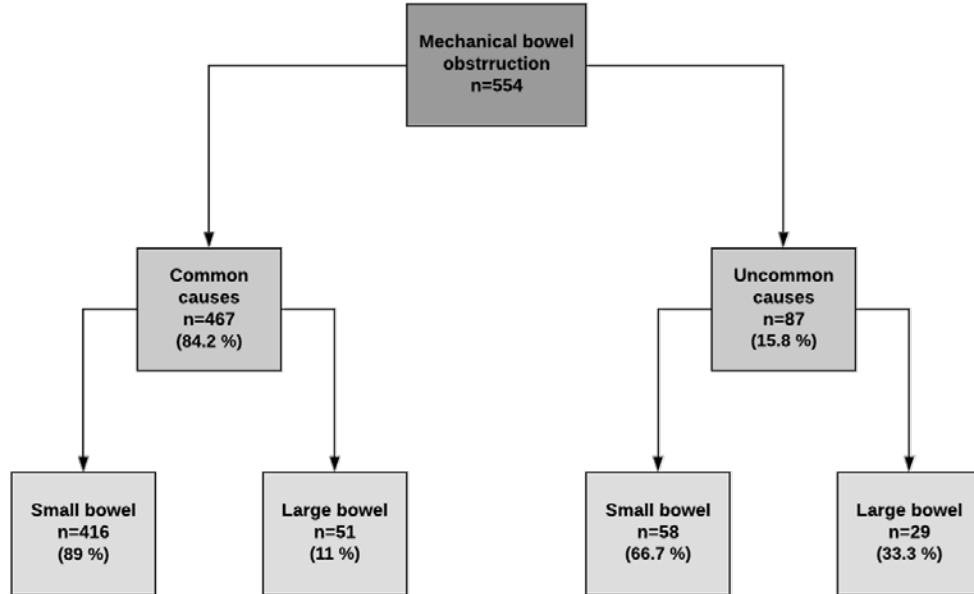
Figure 1. Causes of mechanical bowel obstruction

Figure 2. A 65-year-old patient who previously underwent gastrointestinal stromal tumor operation. A properly confined, recurrent gastrointestinal stromal tumor that presses the terminal ileum in the axial non-contrasted CT image(arrow).

Computed tomography imaging

CT examinations were performed using a 2-detector machine (Siemens Somatom Spirit Dual Slice CT Scanner, Siemens Healthcare, Erlangen, Germany). CT acquisitions were performed from the diaphragm to the pelvis in patients in the supine position. The parameters were the following: collimation of 0.625mm, slice thickness of 3.0mm with millimeter reformations.

CT investigations were done with an iodinated contrast agent (300 mgI/ml Omnipaque ™ GE Medical Systems, Milwaukee, WI) given intravenously or without any contrast materials. Contrast material was used 2cc per kg, up to a maximum of 150 cc, injected at 4cc per second. Scanning started at 40 s delay. Non-enhanced CT examinations performed because of contraindication to the usage of contrast material. All CT reviews reviewed in the PACS system (Medipacs, Datamed, Ankara). Images were taken on the axial plane and analyzed. One reviewer, an experienced radiologist (16 years experience in computed tomography explication) assessed CT examination and the final report was confirmed. The confirmation standard for the existence or lack of mechanical intestinal obstruction was reviewed by the operator. The conirmation of diagnosis was relied on historical and clinical records during discharge, operation results,

and pathological findings. The reviewer gathered the following input; the existence of enlarged intestine proximally and decompressed intestine distally, existence of transition point or a mass causing obstruction, and existenceof ischemia and/ or closed loop. Cases with mechanical small intestine obstruction and meeting the inclusion criteria were investigated from hospital data.
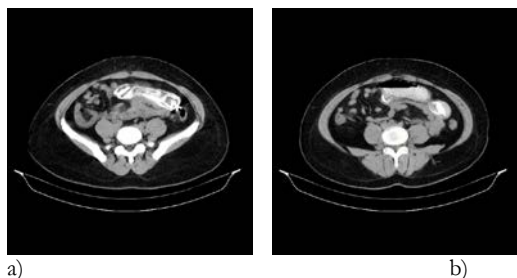
Figure 3. A 27-year-old woman with severe abdominal pain and nausea. Axial CT images show that's a deflated gastric balloon within the small bowel with proximal small bowel dilatation(a,b).

In 48 of 87 patients, CT was performed with enhanced and 39 non-enhanced. Mechanical intestinal obstruction was diagnosed found on the enlarged small intestine proximally (> 3 cm) and the collapsed small intestine distally $\pm$ the transition point (described by the level between the enlarged proximally and collapsed small intestine distally). The reason for obstruction was searched. The IV contrast agent is used for the evaluation of ischemia. Intestinal ischemia/infarction has been recommended when mesenteric fluid/roughness is a combination of small intestine wall thickening less than five mm, decreased, or no intestinal wall enhancement. The first striking sign in colon obstruction is the dilatation of the colon. The normal colon caliber is 3-8 cm. Expansion of the proximal colon segment and distal decompression suggest obstruction. The presence of air-fluid levels in the loops of the colon shows the presence of acute obstruction.

Statistical analysis

Statistical analysis was performed using the statistical package SPSS software (Version 25.0, SPSS Inc., Chicago, IL, USA). Categorical measurements were summarized as numbers and percentages, and continuous measurements were summarized as mean and standard deviation. Comparisons between groups were applied using the Student t-test. In this study, sensitivity, specificity, positive predictive values, and negative predictive values between ECT,

NECT, and surgical findings were evaluated and differences between methods were evaluated by 2019 MedCalc Software Ltd. If continuous variables were normal, they were described as the mean±standard deviation (p>0.05 in Kolmogorov-Smirnov test or Shapira-Wilk (n<30)), and if the continuous variables were not normal, they were described as the median. Comparisons between groups were applied using the Student t-test for normally distributed data and Mann Whitney U test was used for the data not normally distributed. Statistical significance was taken as 0.05 in all tests.

RESULTS

The population included 46 females and 41 males and the age range from 20 to 81 (mean 53, S.D. 19). The mean BMI of patients was 36.1±6.4. All patients had mechanical bowel obstruction. 54% (47/87) of the patients were also confirmed in surgery. In our clinic, 554 patients were hospitalized with the diagnosis of mechanical obstruction between the years of 2009-2018, and 467 (84.2 %) of them were due to common causes and 87 (15.8 %) of them due to uncommon causes. Of the common causes, 416 (89 %) were caused by the small intestine and 51 (% 11) by the large intestine. Common causes of obstruction related to the small intestine were as follows: 295 (70.5%) were postoperative adhesions, 70 (16.3%) were external hernias, 51 (13.2%) were neoplasms. Primary colon cancer was the cause in 42 (82.3%) patients with large bowel obstruction.

Causes of uncommon bowel obstructions were shown in Table 1. Of the patients with uncommon mechanical obstruction, 58 (66.7 %) were caused by the small intestine, and 29 (33.3%) by the large intestine. The causes of uncommon small bowel obstruction were Chron's disease, endometriosis, gastrointestinal stromal tumor (figure 2), and Meckel diverticulitis respectively. One of the very rare causes of obstruction in the small intestine was the migration of deflated intra-gastric balloon (figure 3) and the other was lymphoma of the small intestine (figure 4). The uncommon causes of large bowel obstructions were volvulus(sigmoid), acute diverticulitis, ulcerative colitis, and fecaloma respectively. One of the infrequent causes of obstruction in the large intestine was Hirschsprung's disease (figure 5). Small and large intestine uncommon mechanical obstructions are analyzed related to age, BMI, enhanced or non-enhanced CT. When compared to uncommon causes of the small and large bowel with age, BMI, and use

of contrast or not, no significant difference was detected between them (Table 2). Sensitivity, specificity, PPV, NPV, and diagnostic accuracy of enhanced and non-enhanced CT findings compared

with surgery as the gold standard are reported in Table 3 in the detection of the small bowel and large bowel obstructions.

Table 1. Uncommon causes of bowel obstruction

| Bowel obstruction	n=87	%
Small bowel	58	66.7
Chrohn disease	13	15.1
Endometriosis	11	12.6
Gastrointestinal stromal tumor	7	8.1
Meckel diverticulitis	6	6.9
Intussusception	5	5.8
Mesenteric ischemia	4	4.5
Ischemic bowel	4	4.5
Internal herniation	4	4.5
Lymphoma	2	2.3
Foreign bodies	2	2.3
Large bowel	29	33.3
Volvulus(sigmoid)	7	8.1
Acute diverticulitis	7	8.1
Ulcerative colitis	6	6.9
Fecaloma	5	5.8
Foreign bodies	2	2.3
Hirschsprung disease	1	1.1
Ischemic bowel	1	1.1

Table 2. Patients characteristics and CT features

|	Uncommon-causes small bowel (n=58)	Uncommon-causes large bowel (n=29)	Total (n=87)	p
Age	54.6±14.4	49.8±14.1	53.0±14.4	0.142
BMI	35.8±4.1	36.9±4.4	36.2±4.2	0.248
ECT	32(55.2)	16(55.2)	48(55.2)	1.000
N-ECT	26(44.8)	13(44.8)	39(44.8)	

BMI: body mass index, ECT: enhanced computed tomography, N-ECT:non- enhanced computed tomography

Table 3. Sensitivity, specificity of ECT and N-ECT

	Surgical findings		Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy
	Uncommon causes small bowel	Uncommon causes large bowel					
ECT							
Small bowel	31	1	%93.9 (95 % CI 79.8-99.3)	%93.3 (95 % CI 68.8-99.8)	%96.9 (95 % CI 82.3-99.5)	%87.5 (95 % CI 64,5-96.4)	%94 (83-99)
Large bowel	2	14					
N-ECT							
Small bowel	24	2	%96 (95 % CI 79.6-99.9)	%85.7 (95 % CI 57.28-98.2)	%92.3 (95 % CI 63.5-98.8)	%92.3 (95 % CI 79.1-98.4)	%92.3 (79-98)
Large bowel	1	12					
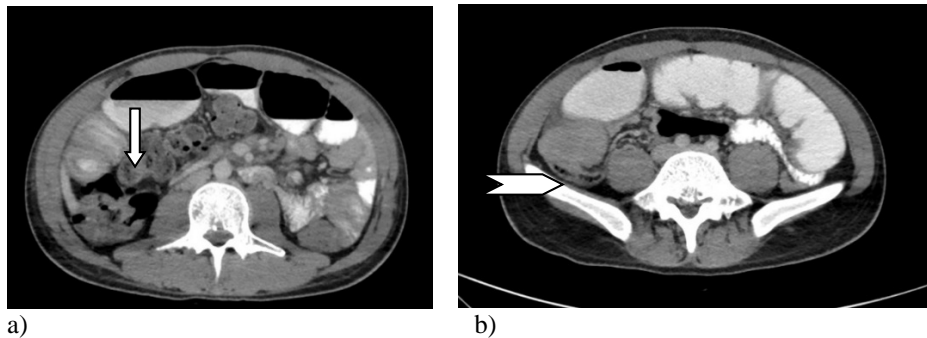
Figure 4. Diffüse Hodgkin Lymphoma in a 45-year-old man who presented with a history of abdominal pain, vomiting. A contrast-enhanced CT scan shows an ileocolic intussusception(arrow)(a) with a thickening of the terminal ileum(arrowhead)(b).
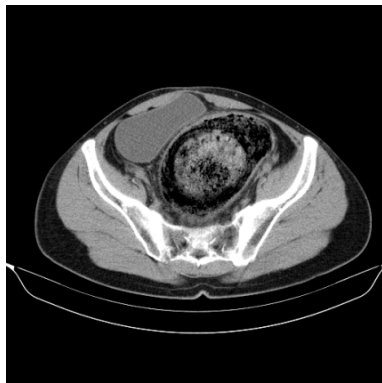
Figure 5. 37-year man with constipation and abdominal pain. Axial unenhanced abdominopelvic CT images show significant dilatation and fecal impaction of the sigmoid colon and asymmetric wall thickening. After surgery, Hirschsprung disease was confirmed

DISCUSSION

The increased frequency of the condition and widespread use of diagnostic imaging has revealed uncommon causes of mechanical bowel obstruction. Computed tomography has been known as more accurate than plain radiography in detecting mechanical intestinal obstruction. Although there are many studies on the use of computed tomography with and without contrast material in detecting intestinal obstructions, the study comparing contrast and non-contrast tomography findings in uncommon bowel obstructions is very limited. In our study, the diagnostic accuracy of contrast-enhanced and non-contrast-enhanced computed tomography detecting uncommon mechanical bowel obstruction was 94% and 92.3% respectively (p> 0.05).

CT is a routine technique to assess small intestine and large intestine obstruction. CT imaging of the small intestine helps to recognize and prepare many of its common diseases, such as small bowel obstruction, ischemia, and neoplasms. CT is the utmost significant image method in evaluating known or suspected LBO patients. It can be obtained easily, it is carried out quickly, it enables evaluation of potential complications and enables the imaging of extra-colon structures. The emergence of multi-detector computed tomography scanners with advanced technological protocols resulted in a quicker and more useful image, especially in acute conditions. CT has 81-94% sensitivity and 96% specificity in diagnosing high-grade obstructions[18]. Recognizing small bowel obstruction in CT requires discriminating proximally enlarged loops and distally normal or collapsed loops. A small intestine diameter higher than 2.5 cm is contemplated as dilated. When a transition point is observed, the diagnosis is more accurate[19]. In a study by Burkill GJC et al. showed that 70% of small intestinal obstruction is due to postoperative adhesions[18]. In our study, 71% of small intestine obstructions were found to be due to postoperative adhesions. Small intestinal obstructions frequently result frm postoperative adhesions.

In our study, 10.4% of causes of mechanical bowel obstruction were due to uncommon small bowel obstruction. Among these, the most common Crohn's disease was 15.1%, endometriosis 12.6%, gastrointestinal stromal tumor 8.1%, Meckel's diverticulitis 6.9%, intussusception 5.8%. Various studies have implied that less frequent causes of SBO are inflammatory bowel disease, trauma, intussusception, gallstones, foreign bodies, and endometriosis, which make up about 10% of cases of obstruction[5,20]. Our study revealed that in rare

obstructions of the small intestine, the sensitivity and specificity of contrast-enhanced CT were 93.9%, 93.3%, and non-contrast-enhanced CT was 96% and 85.7%. There was no statistically significant difference between them although there is no significant difference between them, contrast-enhanced CT is preferred in acute mechanical obstructions because of its better evaluation of ischemic findings and mesenteric vascular structures. However, in the case of contraindications in terms of the use of contrast, non-contrast CT is a reliable method for the diagnosis of mechanical obstruction.

One of the rare small bowel obstructions in a review article published in February 2019 was small bowel obstruction caused by deflation and migration of the balloon placed in the stomach. The total number of reported cases in this article was 10. There was another case reported by Gabriel A. Molina et al, Published in March 2019 [21]. Our patient was the 12th case in which mechanical bowel obstruction determined in the English literature (Figure 3).

In our study, uncommon large intestine obstructions accounted for 5.2% of all mechanical obstruction several studies conducted that lesser reasons of LBO involve volvulus (10-15%), diverticulitis (5-10%), inflammatory intestinal disease, intestinal ischemia (4-8%), fecal impaction and other rare and unusual diagnoses (less than 5%) [5,7,9]. The uncommon causes of LBO in our study were volvulus (sigmoid) 8.1%, acute diverticulitis 8.1%, ulcerative colitis 6.9%, fecaloma 5.8%. Our study revealed that in rare obstructions of the large bowel, the sensitivity and specificity of contrast-enhanced CT were 99,3%, 99,8%, and non-contrast-enhanced CT was 99,9 and 98,2%. There was no statistically significant difference between them. Even no significant difference between them, additional benefits of contrast-enhanced CT are visualization of complications associated with LBO (particularly ischemia and inflammation). However, when contrast use is contraindicated, non-contrast CT is a reliable test for the diagnosis of large bowel mechanical obstruction.

In our series, one of the rare causes of large bowel obstructions was mechanical obstruction due to fecaloma caused by Hirschsprung's disease. Although late diagnosis HD is uncommon, a heightened awareness of this potential diagnosis should be entertained in the patient with long-standing and refractory constipation [22].

In the study conducted by M. Atri et al, they found that non-enhanced CT showed similar diagnostic accuracy in determining the mechanical small intestinal obstruction and transition point compared to CT with enhanced. They found sensitivity of 89.8%, specificity of 80.4%, NPV of 86%, PPV 85.5%, diagnostic accuracy of 85.7% with non-enhanced CT in mechanical obstruction and sensitivity of 88.1%, specificity of78.3%, NPV of 83.7%, PPV of 83.9%, diagnostic accuracy of 83.8% with enhanced CT [17]. In our study, non-enhanced CT was similar diagnostic accuracy to enhanced CT for both small and large bowel obstructions.

This study has some limitations. The first limitation was retrospective in nature. The second limitation was the confirmation of the final report by a single radiologist. The third limitation was the small number of cases with complicated bowel obstruction.

Knowledge of the conditions causing uncommon small and large bowel obstructions and the imaging features help the radiologist promptly trigger patients, facilitating fast and convenient management. Non-enhanced CT was a similar diagnostic accuracy, sensitivity, and specificity compared to enhanced CT for identifying the location, severity, and etiology of bowel obstruction.

REFERENCES

1. Welch JP. Bowel obstruction: Differential diagnosis and clinical management. United States: WB Saunders CBS Educ and Professional Publ. 1987; 18.
2. Sielezneff I, Karoui M. Prise en charge ducancer colique en occlusion: Rapport présenté au 118e Congrès français de chirurgie. 2016.

3. Runkel NS, Schlag P, SchwarzV, HerfarthC. Outcome after emergency surgery for cancer of the largein testine. Br J Surg. 1991;78:183–8.

4. Taourel P, Kessler N, Lesnik A, Pujol J, Morcos L, Bruel JM. Helical CT of large bowel obstruction. Abdom Imaging. 2003;28:267-75.

5. Jaffe T, Thompson W. Large bowel obstruction in the adult: classic radiographic and CT findings, etiology, and mimics. Radiology. 2015;275:651–63.

6. Cooper JM, Thirlby RC. Small bowel obstruction. Curr Treat Options Gastroenterol. 2002;5:3–8.

7. Cappell MS, Batke M. Mechanical obstruction of the small bowel and colon. Med Clin North Am. 2008;92:575–7.

8. Ramanathan S, Ojili V, Vassa R, Nagar A. Large bowel obstruction in the emergency department: imaging spectrum of common and uncommon causes. J Clin Imaging Sci. 2017;7:15.

9. Drożdż W, Budzyński P. Change in mechanical bowel obstruction demographic and etiological patterns during the past century: observations from one health care institution. Arch Surg. 2012;147:175–80.

10. Frager DH, Baer JW. Role of CT in evaluating patients with small-bowel obstruction. Semin Ultrasound CT MR. 1995;16:127–40.

11. Kurochka S, Costa Dias S, Gonçalves LFP, Torrão H, Costa AC, Leite C et al. CT findings in the small bowel pathology: A pictorial essay. ECR. 2010 Poster No: C-1458.

12. Maglinte DDT, Heitkamp DE, Howard TJ, Kelvin FM, Lapppas JC. Current concepts in imaging of small bowel obstruction. Radiol Clin North Am. 2003;41:263-83.

13. Smith RC, Rosenfield AT, Choe KA, Essenmacher KR, Verga M, Glickman MG et al. Acute flank pain: comparison of non-contrast-enhanced CT and intravenous urography. Radiology. 1995;194:789–94.

14. Sommer FG, Jeffrey Jr RB, Rubin GD et al. Detection of ureteral calculi in patients with suspected renal colic: value of reformatted noncontrast helical CT. AJR Am J Roentgenol 1995;165:509–13.

15. Lane MJ, Liu DM, Huynh MD, Jeffrey Jr RB, Mindelzun RE, Katz DS. Suspected acute appendicitis: nonenhanced helical CT in 300 consecutive patients. Radiology. 1999;213:341–6.

16. Christopher FL, Lane MJ, Ward JA, Morgan JA. Unenhanced helical CT scanning of the abdomen and pelvis changes disposition of patients presenting to the emergency department with possible acute appendicitis. J Emerg Med. 2002;23:1–7.

17. Atri M, McGregor C, McInnes M, Power N, Rahnavardi K, Law C, et al. Multidetector helical CT in the evaluation of acute small bowel obstruction: comparison of non-enhanced (no oral, rectal or IV contrast) and IV enhanced CT. Eur J Radiol. 2009;71:135-140.

18. Burkill GJC, Bell JRG, Healy JC. The utility of computed tomography in acute small bowel obstruction. Clin Radiol. 2001;56:350–9.

19. Furukawa A, Yamasaki M, Furuichi K, et al. Helical CT in the diagnosis of small bowel obstruction. RadioGraphics. 2001;21:341–55.

20. Sawai RS. Management of colonic obstruction: a review. Clin Colon Rectal Surg. 2012;25:200–3.

21. Molina GA, Palacios Gordon MF, Jerez Ortiz JR, Chong Menendez R, Constante Ruiz JE, Padilla Paredes HI et al. Bowel obstruction due to the migration of the deflated intragastric balloon, a rare and potentially lethal complication. J Surg Case Rep. 2019; 2019(4): rjz091.

22. Casey M. Calkins. Hirschsprung disease beyond infancy. Clin Colon Rectal Surg. 2018;31:051-060.