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The role of computed tomography signs in diagnosis of patients with small bowel obstruction

İnce bağırsak obstrüksiyonlu hastaların tanısında bilgisayarlı tomografi bulgularının rolü

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ABSTRACT

Aim: The goal of this prospective study is to evaluate the prognostic impact of computed tomography (CT) signs in the analysis of small bowel obstruction (SBO).

Patients and Method: Sixty consecutive patients with acute abdominal pain who were examined using abdominal CT to diagnose SBO were included in the study. 47 patients of them (26 male; 21 female and mean age, 60 years), were evaluated. CT evaluation parameters were mesenteric congestion, transition zone, feces sign, intramural air and intraperitoneal free fluid.

Results: There was a statistically significant association between the SBO diagnosis and CT findings for mesenteric congestion, transition zone and intramural air ($p<0.05$ for all). These CT signs had greatest sensitivity and positive predictive value (PPV) in diagnosis of SBO. The combination of mesenteric congestion, transition zone and intramural air showed a significant association in the diagnosis of SBO ($p<0.05$). Small bowel feces sign and intraperitoneal free fluid findings had no statistically significant value in the diagnosis of SBO ($p>0.05$). When three or more CT findings were seen together, there was a statistically significant association in the diagnosis ($p<0.05$).

Conclusion: Mesenteric congestion and transition zone had the highest sensitivity and PPV in diagnosing SBO. The combination of mesenteric congestion, transition zone and intramural air and the presence of three or more CT signs markedly increase the specificity in diagnosis of SBO.

Keywords: computed tomography, feces sign, transition zone, mesenteric congestion, small bowel obstruction,

ÖZ

Amaç: Bu prospektif araştırmanın amacı, ince barsak tıkanıklığı (İBT) değerlendirilmesinde bilgisayarlı tomografi (BT) bulgularının prognostik değerini araştırmaktır.

Hastalar ve Yöntem: Akut karın ağrısı olan ve İBT araştırılmasında BT çekilen altmış hasta çalışmamıza dahil edildi. Bunlardan, 47 hasta (26 erkek; 21 kadın ve ortalama yaş; 60) nın sonuçları değerlendirildi. BT değerlendirme parametreleri olarak: mezenterik kirlenme, geçiş zonu, feces işareti, intramural hava ve intraperitoneal serbest sıvı kullanıldı.

Bulgular: Mezenterik kirlenme, geçiş zonu ve intramural hava BT bulguları ile İBT tanısı arasında istatistiksel anlamlı ilişki bulundu ($p<0.05$). Bu BT bulguları İBT tanısında yüksek sensitivite ve pozitif prediktif değere (PPD) sahiptir. Mezenterik kirlenme, geçiş zonu ve intramural hava bulgularının kombinasyonu ile İBT tanısı arasında istatistiksel anlamlı bir ilişki saptandı ($p<0.05$). İnce barsak feces bulgusu ile intraperitoneal serbest sıvı bulgusunun İBT tanısı ile arasında istatistiksel anlamlı bir ilişki saptanmadı ($p>0.05$). Üç veya daha fazla BT bulgusunun beraber bulunması durumunda İBT tanısında istatistiksel anlamlı değeri olduğu saptandı ($p<0.05$).

Sonuç: Mezenterik kirlenme ve geçiş zonu bulguları İBT tanısında en yüksek sensitivite ve PPD sahiptir. Mezenterik kirlenme, geçiş zonu ve intramural hava bulgularının kombinasyonu ile üç veya daha fazla BT bulgusunun beraber bulunması durumunda İBT tanısında spesifite belirgin oranda artmaktadır.

Anahtar Kelimeler: bilgisayarlı tomografi, feces işareti, geçiş zonu, mezenterik kirlenme, ince barsak tıkanıklığı,

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Small bowel obstruction (SBO) is a frequent cause of acute abdominal pain in patients (12-16%) [1]. If the obstruction is accompanied by complications such as intestinal ischemia or perforation, the risk of mortality significantly increases. Thus, early and accurate diagnosis plays an important role in reducing morbidity and mortality in patients with SBO.

In SBO, imaging is the most important diagnostic tool when SBO patients show non-specific clinical and laboratory results. In addition to diagnosis imaging also shows cause and levels of obstruction and identifies its possible complications. From its first usage the CT has the greatest sensitivity and specificity in detecting SBO [1,2]. In literature the sensitivity of CT in diagnosis of SBO range from 63% to 96% and specificity from 78% to 96% [2-4]. The CT is useful not only in diagnosis of SBO but also in preoperative demonstration of complication such as strangulation which is pivotal in preoperative planning [5]. In current abdominal computed tomography (CT), with its widespread availability, short imaging time that decreases motion and breath artifacts, and thin section images that show bowel pathologies in different orthogonal planes, may become the first choice imaging method in diagnosing patients with SBO and acute abdominal pain [6,7].

Previous studies have investigated the role of CT findings in diagnosing SBO and SBO complications and for treatment decisions, but there are currently no consensus recommendations [1,8-16]. No studies were found that investigated the diagnostic value of combinations of CT findings. The goal of this prospective study is to evaluate the prognostic impact of CT signs in the analysis of SBO.

MATERIALS AND METHODS

Between April 2007and January 2008, sixty consecutive adult patients with flank abdominal pain, abdominal distention, constipation, vomiting and nausea who had been referred for CT examination were included in this prospective study. We excluded teen patients because of lack of follow-up clinical and laboratory data. Also three patients with non-enhanced CT examination were excluded from the study. Overall, 47 patients (26 males and 21 females) with ages ranging from 18 to 89 years (mean age, 60 years) were included in the study. The diagnosis of SBO was based on the clinical notes at the time of discharge, surgical findings and pathology reports in those patients who underwent surgery. A diagnosis of SBO was made for 28 patients based on surgery and pathology. The response to nasogastric (NG) tube decompression and medical treatment in 10 patients who did not undergo surgical intervention was accepted in the diagnosis of SBO. The patients outcome was defined as a recovery of clinical signs, reduction in leukocytosis (<10000,/mm3) and in neutrophils<85% and a healing of the CT findings [17,18]. Nine patients who recovered without treatment during follow-up were considered to have non-obstructive bowel dilatation.

The study protocol followed the ethical guidelines of the Declaration of Helsinki, and the ethics committee of Trakya University Medical School approved the study. Informed consent was obtained from all individuals.

CT imaging techniques and interpretation criteria: CT examinations were performed using a two-detector CT system General Electric Hi Speed NX/i sys 8.10 (GE Medical Systems, Milwaukee, Wis). Protocols for routine abdominal CT were used for all patients (120 kVp; 300 effective mAs; rotation time, 0.8 sec; colimation, 10 mm; pitch factor, 0.938; helical factor, 15.0). CT examinations were performed during deep inspiration in a supine position.

We started the CT scan in all patients 50-60 seconds after a contrast injection to show peak bowel enhancement [19]. Intravenous contrast material (100 mL of a 300 mg/ml solution; OmnipaqueTM GE Medical Systems, Milwaukee, WI) was administered using a power injector at a rate of 2.5-3 mL/sec via a peripheral venous line. To clearly evaluate the bowel wall and to eliminate possible bowel wall ischemia, oral contrast medium was not administered to our patients.

Two radiologists, one senior radiologist with 20 years of experience (M.K.D.) and a radiologist with 5 years of experience (I.S.) in abdominal radiology, who were blinded to the final outcome reviewed all CT examination in consensus.

Normal small bowel diameter is a maximum of 2.5 cm in adults, and bowel loops that had a larger diameter were considered to be dilated [20]. For CT image evaluation, parameters that were taken into consideration in the diagnosis of SBO were mesenteric congestion (hazy fluid attenuation in the mesentery of the involved intestinal segment)(Figure 1), transition zone (decompressed small bowel distal to the dilated small bowel)(Figure 2), small bowel feces sign (debris and

gas bubbles within the obstructed small bowel lumen) (Figure 3), intramural air (Figure 1) and the presence of free intraperitoneal fluid, regardless of the amount.

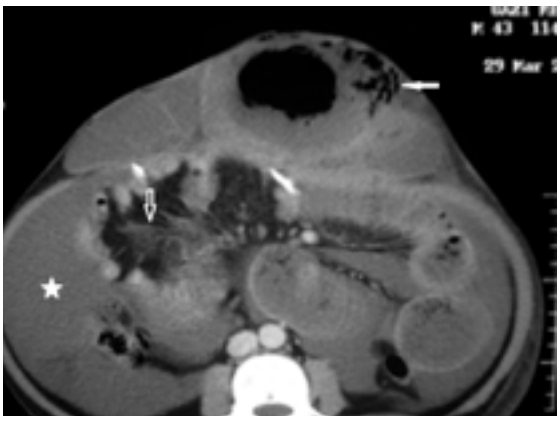
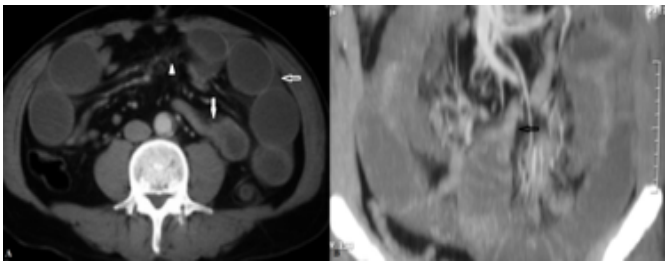


Figure 1. Contrast-enhanced abdominal CT image in a patient with an incarcerated anterior abdominal wall hernia shows mesenteric congestion (open arrow), intraperitoneal free fluid (*) and intramural air in herniated dilated bowel wall (white arrow).

Figure 2. Contrast-enhanced abdominal CT images in a patient with adhesional small bowel obstruction shows a transition zone between dilated and collapsed bowel segments (white arrow) (A). In this image, intraperitoneal free fluid (open arrow) and mesenteric congestion (arrowhead) are also seen (A). A coronal multiplanar reformatted (MPR) image (B) shows the transition zone (open black arrow).



Statistical analysis: Statistical analysis was performed using the program SPSS 19.0 (IBM Corp., Chicago, IL, USA). Descriptive statistics for categoric variables were reported with frequencies and percentages. Using surgical and pathologic findings and healing with NG tube decompression as reference standard for the SBO diagnosis we calculated sensitivity, specificity positive predictive value (PPV) and negative predictive value (NPV) for each CT sign. The association between each CT sign and SBO was assessed by using Fisher's exact tests. A p value of less than 0.05 was considered to be statistically significant.

RESULTS

No statistically significant correlation was found between patient demographics including age, gender and the diagnosis of SBO (p>0.05).

Of the 38 patients diagnosed with SBO, 17 had a history of abdominal surgery (10 appendectomy, 4 cholecystectomy, 3 hysterectomy) and adhesions, 12 had tumors (6 small bowel adenocarcinoma, 3 carcinoid tumor, 2 sarcoma, 1 lymphoma), 7 had hernia, 1 had perforated appendicitis and 1 had small bowel perforation (Table 1).

Table 1. Reasons for small bowel obstruction

Reason	Number of Patients
Adhesion	17 (%)
Tumor	12 (%)
Hernia	7 (%)
Other*	2 (%)
*Perforated appendicitis in 1 patient and bowel perforation in 1 patient	

In the 38 patients who were diagnosed with SBO, transition zone findings were established in 36 patients (94.7%), mesenteric congestion in 34 patients (89.5%), intramural air in 31 patients (81.6%), intraperitoneal free fluid in 20 patients (52.6%) and small bowel feces sign in 19 patients (50%). Sensitivity and specificity values of CT signs used to diagnose SBO are presented in Table 2.

A statistically significant association in SBO diagnosis was found for mesenteric congestion, transition zone and intramural air CT signs (p< 0.05). These CT signs also have a greatest sensitivity (89.4%, 94.7% and 81.5% respectively) and PPV (91.9%, 87.8% and 91.1% respectively). The specificity (66.6%, 44.4% and 66.6% respectively) and NPV (15.8%, 10.5% and 15.8% respectively) were relatively low (Table 2). Small bowel feces sign and intramural air signs had no statistically significant value in the diagnosis of SBO (p>0.05).

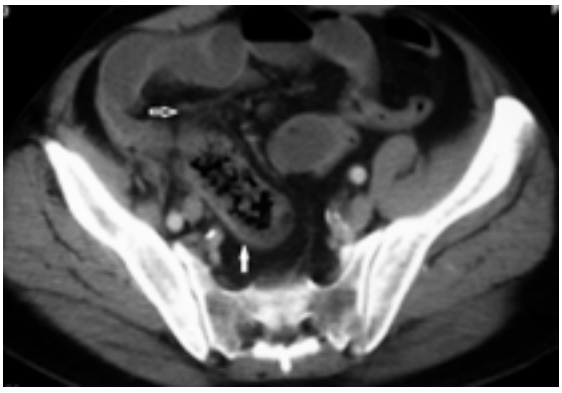


Figure 3. Abdominal CT image shows a dilated bowel segment with debris and gas bubbles, also called a feces sign (white arrow). Minimal mesenteric congestion (open white arrow) also was seen in the cranial portion of the dilated bowel segment.

When CT signs were investigated using dual combinations of CT signs, a statistically significant association in the diagnosis was found only for the combinations of transition zone and mesenteric congestion (n=33), transition zone and intramural air (n=31), and mesenteric congestion and intramural air (n=31) ($p<0.05$; Table 2). The sensitivity (84.2%, 76.3% and 76.3% respectively), specificity (88.8%, 77.7% and 77.7% respectively) and PPV (96.9%, 93.5% and 93.5% respectively) of these sings are higher than other dual combinations of CT signs (Table 2). There was no significant association in the diagnosis of SBO for dual combinations of feces sign and intraperitoneal free fluid signs ($p>0.05$; Table 2).

To investigate the combinations of CT signs, we also evaluated the value of the number of these signs used in the diagnosis of SBO. We observed that when three or more CT signs are seen together (n=31), the sensitivity increased to 89% and PPV to 87.1% (Table 2). The combination of three or more CT signs was significant role in the diagnosis of SBO ($p<0.05$).

DISCUSSION

Our study shows that mesenteric congestion and transition zone had the greatest sensitivity and PPV for the diagnosis of patients with SBO and they can be accurately used to making a diagnosis. As expected, the coexistence of transition zone and mesenteric congestion also had a high diagnostic accuracy and the sensitivity, specificity and PPV rise markedly.

Transition zone was the finding with the greatest sensitivity in our study, which is in agreement with previous studies [1,20,21]. As in literature this CT sign has a statistical significant association with SBO diagnosis according to our study [21]. The sensitivity of this CT sign significantly increased along with severity and the grade of SBO [4-21]. But the diagnostic value of this CT sign remains controversial. In a study by Colon et al., the transitional zone showed an obstruction level with statistically significant accuracy, and this could be used in the preoperative planning for SBO patients [22]. However, our results and those of other studies [12,22,23] show that the observation of transition zone alone in SBO had a low specificity and this sign do not show significant relationship with the presence of complications and the necessity for surgical intervention. According to the guideline for management of patients with SBO, the requirement for surgery is demonstrated first by failure of decompression, treatment and then by radiologic findings [24].

Table 2. Diagnostic values of CT findings

CT Sign	Sens.	Spec.	PPV	NPV	P*
Mesenteric congestion (n=34)	89.47	66.66	91.89	15.78	0.001
Transition zone (n=36)	94.73	44.44	87.8	10.52	0.009
Intramural air (n=31)	81.57	66.66	91.17	15.78	0.008
Feces sign (n=19)	50.00	66.66	86.36	15.78	0.301
Intraperitoneal free fluid (n=20)	52.63	44.44	80	10.52	0.586
Transition zone-Mesenteric congestion (n=33)	84.21	88.88	96.96	21.05	0.000
Transition zone-Intramural air (n=31)	76.31	77.77	93.54	18.42	0.004
Mesenteric congestion-Intramural air (n=31)	76.31	77.77	93.54	18.42	0.004
Mesenteric congestion-Intraperitoneal free fluid (n=20)	47.36	77.77	90	18.42	0.160
Feces sign-Mesenteric congestion (n=18)	44.73	88.88	94.44	21.05	0.064
Feces sign-Intramural air (n=18)	44.73	88.88	94.44	21.05	0.062
Feces sign-Transition zone (n=19)	44.73	77.77	89.47	18.42	0.197
Feces sign-Intraperitoneal free fluid (n=15)	31.57	66.66	80	15.78	0.604
Intraperitoneal free fluid-Intramural air (n=19)	44.73	77.77	89.47	18.42	0.197
Intraperitoneal free fluid-Transition zone (n=20)	47.36	77.77	90	18.42	0.160
3 and more CT findings (n=31)	89.47	44.44	87.17	10.52	0.033
* P value was calculated using the Fisher's exact test					

Mesenteric congestion is an early indicator of complications in SBO patients, and it is connected to a disruption in venous circulation at the level of the obstruction [13]. In our study mesenteric congestion shows high sensitivity and PPV (89.4% and 91.9% respectively) but low specificity (66.6%). Because of its etiopathogenesis, the mesenteric congestion sign is seen also in conditions such as mesenteric ischemia, radiation enteritis and inflammatory bowel disease [8]. We

believe that thus lead to decrease in specificity of this CT sign. In a study by Zielinski et al., a positive correlation was reported between mesenteric congestion and complications in the patient, which indicates the need for surgery [9]. In a meta-analysis of studies on SBO, the sensitivity and specificity of the mesenteric congestion finding ranged from 38%-94% and 25%-88%, respectively and this finding did not have significant diagnostic value for ischemia and strangulation in SBO patients [5,15]. Our sensitivity and specificity value was consistent with literature (89% and 66% respectively) and we found significant association with mesenteric congestion sign and SBO diagnosis. The mesenteric congestion sign was good diagnostic value but is unuseful in prognosis prediction and treatment decision. Additionally, intramural air was rarely observed as a finding of obstruction [5,25]. Our study shows significant association of the intramural air sign along with the moderate specificity (66%) in diagnosis of the SBO. Differences in results were based on selection bias in most previous studies that investigated complications of SBO.

In our study, the presence of small bowel feces sign and intraperitoneal free fluid had no significant relevance to the diagnosis of SBO. However, there is no consensus on the diagnostic value of these CT findings [6,8-12,26,27]. In addition, findings of feces sign and intraperitoneal free fluid had many different etiologies such as malignity, metabolic causes and cirrhosis [11,26,28]. Thus lead to decrease in sensitivity and specificity of this CT signs in our study.

The combination of intraperitoneal free fluid, feces sign and intramural air did not show any contribution to the diagnosis and management of patients with SBO. We found that the presence of three or more CT findings together had a better diagnostic value for SBO patients than combinations of two findings. When three or more findings were considered together, the sensitivity rose markedly while the specificity fell, independent of the individual sensitivities and specificities. In addition, the likelihood of complications in SBO patients with three or more CT findings was related to a higher complication rate [15]. In patients with a complicated clinical course, such as those with strangulated and ischemic SBO, only a combination of CT signs was shown to have an higher diagnostic value [6,13], which is consistent with our study results.

Limitation: There were several limitations in our study. First this study was conducted at a single-center with a relatively small patient population. In addition, to avoid selection bias and reflect the efficacy of CT findings in the daily routine, we included patients treated both surgically and medically. Because of the relatively small number of patients, we could not compare combinations of CT findings between patients with or without surgery. Second prevalence of disease in our study population was relatively high and thus leads to decrease of NPV values of CT signs. Our study was expressed on patients with suspicions for SBO. Thus influenced on our sensitivity, specifity, PPV and NPV. Our results shows that CT signs reach high diagnostic value only in combination with clinical and laboratory results and in combination each other.

In conclusion our findings show that mesenteric congestion, transition zone and intramural air, and the coexistence of these signs are valuable for the diagnosis of patients with SBO. Intraperitoneal free fluid and feces sign, and the combination of these two signs with other CT signs had no statistical significance in diagnosis of SBO. However, the presence of three or more CT signs together had statistical value in the diagnosis of SBO patients. We suggest that a combination of CT findings and clinical findings will increase the specificity of the daily routine.

Conflict of interest: The authors declare that there are no actual or potential conflicts of interest in relation to this article.

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