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RESEARCH ARTICLE

Isolated Small Bowel Perforations: Etiology and Management

Ayberk Dursun[1], Gülşen Yücel Oğuzdoğan[2], Kenan Teker[3], Korhan Tuncer[3]

[1]Erciş Şehit Rıdvan Çevik State Hospital, Clinic of General Surgery, Van, Turkey
[2]University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital, Clinic of Radiology, İstanbul, Turkey
[3]University of Health Sciences Turkey, İzmir Tepecik Training and Research Hospital, Clinic of General Surgery, İzmir, Turkey

ABSTRACT

Aim: Small bowel perforations (SBP), which are among the rare causes of an acute abdomen, constitute a potentially fatal emergency. Non-traumatic isolated SBPs are encountered very infrequently. The aim of this study was to highlight the importance of correct diagnosis and early treatment with the help of computerized tomography (CT) findings and to contribute to the literature in light of the rarity of the condition.

Method: Patients who were followed-up for non-traumatic SBP without additional organ injuries between 01.01.2015 and 01.03.2020 were included. Data including demographic and clinical characteristics, anamneses, mortality and morbidity, and type of surgery. Direct and indirect CT findings of the patients were evaluated. The study was retrospective.

Results: A total of 59 patients, of whom 30 were male (50.8%), were included. Mean age was 62.4 years and 52.5% of the patients were older than 65 years. All patients underwent surgery and resection was preferred most frequently (83.1%). Mean duration of hospital stay was 11 days. Duration of hospital stay was significantly longer when major complications developed ($p<0.05$). The only significant relationship in subgroup analyses was identified between ileostomy and the occurrence of major complications ($p<0.05$). The most common causes of perforation were adhesions and metastatic tumor implants (16.9%). The most common cause of the metastases was lung cancer. CT showed intra-abdominal free fluid in 96.6% and free air in 61% of the patients. The rate of free air detection was higher with a history of malignancy ($p<0.05$).

Conclusion: Early diagnosis and treatment is critical in reducing SBP-related mortality and morbidity. When SBP is suspected in the presence of a clinical picture of an acute abdomen, CT is an important guide. SBP should be considered in the differential diagnosis in patients with lung cancer who manifest a clinical picture of an acute abdomen.

Keywords: Emergency surgery, general surgery, radiology, small bowel, small bowel perforation

Introduction

Small bowel perforations (SBP), which are among the rare causes of acute abdomen, constitute a potentially fatal emergency that can result in fecal peritonitis.[1] Non-traumatic isolated SBP that are not accompanied by additional organ injuries or the perforation of another hollow organ are encountered very infrequently. Adhesions and inflammatory bowel disease (IBD) are the most common causes of non-traumatic bowel perforations in developed countries, while infectious causes are more common in developing countries. SBP causes a clinical picture of an acute abdomen. In patients with small bowel or colon perforations, a definitive diagnosis regarding the cause of the perforation is not required prior to operation.[2] In suspected SBP, methods such as ultrasonography should not be the primary imaging method and the importance of computerized tomography (CT) is elevated in the diagnosis.[3] In the treatment of SBP, surgery takes precedence. However, the specific management of the treatment depends on the underlying cause of the perforation.[2] Early identification of SBP would reduce the resulting time to surgical treatment. It may contribute to the initiation of appropriate diagnostic and treatment methods.[4] The investigation of the etiological causes of isolated SBP in

Address for Correspondence: Ayberk Dursun MD,
Erciş Şehit Rıdvan Çevik State Hospital, Clinic of General Surgery, Van, Turkey
E-mail: dursunayberk845@gmail.com **ORCID ID:** orcid.org/0000-0001-9187-0463
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our clinic showed tumor implants to be associated with a much higher rate when compared with other studies. The aim of this study was to highlight the importance of the correct diagnosis and treatment of non-traumatic isolated SBP, to evaluate CT findings and to contribute to the literature given the relative rareness and thus paucity of evidence about management of SBP.

Materials and Methods

Patient Data

This study included patients operated for SBP occurring due to non-traumatic causes that are not accompanied by additional organ injuries, in a single general surgery clinic between 01.01.2015 and 01.03.2020. Data collected included patient demographics, anamneses, history of chronic disease, duration of postoperative hospital stay, 30-day perioperative mortality and morbidity data, type of surgery performed, perforated small bowel segment, daily patient observations and details of patients' follow-up. The complications that developed were categorized based on the Clavian-Dindo Classification (CDC). CDC 3 and 4 complications were evaluated as major complications. Patients younger than 18 years of age and patients with incomplete data were not included in the study.

Computerized Tomography Data

The CT images that were evaluated were obtained with or without contrast on the HITACHI Supria 64/128 device. Iodized contrast agent diluted with water as oral contrast and non-ionized iodinated contrast material was used as intravenous (IV) contrast. The most common protocol used in our center include mono-phasic portal venous phase injection of 80-120 mL (1.7-2 mL/kg) non-ionized iodinated IV contrast agent followed by 20 mL of saline solution, at 3-5 mL/s using an automated injector from the diaphragmic dome to the proximal femoral diaphysis (mA: 180, scan time: 0.75, kV: 120, FOV: 500 mm, colimation: 0.625x64). The axial slice was thin (1 mm) for all pre- and post-contrast acquisitions, but further thick-slice 5 mm axial and other 3-5 mm coronal and sagittal planes (multiplanar reformations and maximum intensity projection) were obtained. Direct CT findings included, independent of perforation site, the presence of extraluminal gas or extraluminal oral contrast, and bowel wall discontinuity from which contrast, air or luminal contents had spilled. Bowel discontinuity does not invariably cause pneumoperitoneum and may result into a localised phlegmon or an abscess. Indirect signs include segmental bowel wall thickening, abnormal wall enhancement, localized fat stranding and/or free fluid, phlegmon or an abscess, or small bowel distention. Approval for this study was obtained from the University of Health Sciences Turkey, İzmir Tepecik Training and Research Hospital Clinical Research Ethics Committee (approval number: 2021/06-37).

Statistical Analysis

Statistical analyses were performed using SPSS software, version 25.0 (IBM Inc., Armonk, NY, USA). Normality of variables was investigated using analytical methods. Continuous variables with a normal distribution are presented as mean and standard deviation values. Variables with a non-normal distribution are presented as median (Q1-Q3) values. Normally distributed variables were compared using the t-test if continuous and using the Pearson's chi-square of Fisher's exact chi-square tests if categorical while non-normally distributed variables were compared using the Mann-Whitney U test. Independent factors were determined and multivariate logistic regression analysis was conducted. A value of $p<0.05$ was considered statistically significant.

Results

This study included 59 patients, of whom 30 (%) were male. Mean age was 62.4 years and 52.5% of the patients were older than 65 years of age (Table 1). All patients who were followed up for isolated SBP had undergone surgery during the specified date range and non-surgical follow-up was not preferred. The most commonly preferred surgical method was resection + anastomosis (49 patients, 83.1%). This was followed, in descending order, by ileostomy (10.2%) and primary repair (6.7%). The evaluation of the patients' anamneses revealed a history of malignancy in 24 patients (40.7%). The segment in which perforations occurred the most frequently was ileum (45 patients, 76.3%).

Median duration of hospital stay was 11 days. This duration was eight days in patients without major complications and was significantly shorter ($p<0.05$) than the 25 days in those with major complications. Four patients (6.8%) died and all of these patients were older than 65 years of age. The perforation had occurred due to an adhesion in all of these four patients (100%).

When the data of the 10 patients with major complications (CDC 3 and 4) were inspected, factors such as age, gender, history of malignancy, underlying etiological cause and segment of the small bowel with the perforation were not found to significantly influence complication rates ($p>0.05$). The development of major complications was only associated with the performance of ileostomy ($p<0.05$). Again, when all of these factors were evaluated, there was no factor that had a significant effect on the 30-day peri-operative mortality ($p>0.05$).

When the etiological factors were investigated, the most common cause of perforations were adhesions (20.3%), and interestingly, this was followed by tumor implants (16.9%) (Table 2). Among the 10 patients in whom

Table 1. Analysis of the general data of the patients

	All patients (n=59)	No major complications (n=49)	Major complications present (n=10)	p
Age, mean ± SD	62.4±15.6	62.5±16.7	62.4±9.4	0.993
Groups by age, n (%)				**0.494**
Younger than 65	28 (47.5)	22 (44.9)	6 (60)	-
65 and older	31 (52.5)	27 (55.1)	4 (40)	-
Gender, n (%)				**0.731**
Male	30 (50.8)	24 (49)	6 (60)	-
Female	29 (49.2)	25 (51)	4 (40)	-
Presence of malignancy, n (%)	24 (40.7)	18 (36.7)	6 (60)	0.289
Presence of chemotherapy, n (%)	14 (23.7)	12 (24.5)	2 (20)	1.000
Presence of leukocytosis, n (%)	35 (59.3)	27 (55.1)	8 (80)	0.177

SD: Standard deviation

perforations occurred due to tumor implants, the most common primary was lung cancer, in seven patients (70%). While eight of these 10 patients had received a diagnosis of cancer prior to surgery, two patients were diagnosed after perforation. Perforations occurred due to primary small bowel malignancies in two patients (3.4%) and both of these patients received a diagnosis of lymphoma of the small intestine postoperatively.

When the etiological factors were analyzed individually, the complication rate was highest in ischemic perforations, with a rate of 50%. Major complications occurred in two of the four ischemic perforations while this rate was 44.4% in perforations secondary to herniations.

Computerized Tomography Data

All patients included in the study had undergone an abdominal CT preoperatively. The most commonly used method was non-contrast CT in 29 patients (42.9%), followed by IV contrast only CT (23.7%) and oral + IV contrast CT (23.7%) in 14 patients each. Meanwhile, two patients were given only oral contrast. Intra-abdominal free fluid was observed in 96.6% and free air was observed in 61% of all patients (Table 3). In the analysis of the subgroups, the rate of intra-abdominal free air was 83.3% in patients with a history of malignancy, which was significantly higher when compared with those without history of malignancy ($p<0.05$) (Table 3). On CT, the presence of phlegmon or abscess elevated the rate of major complications, although this was not significant ($p>0.05$).

When the CT images of the patients who received chemotherapy were examined, the rate of free air detection was 85.7%, which was significantly higher when compared with those who did not receive chemotherapy (53.3%) (Table 4). The increase in small bowel diameter was greater in patients who did not receive chemotherapy (82.2%) than in patients who did (42.9%) (Table 4). Again, the findings showed free air on CT in 80% of the patients with perforations related to a tumor implant. The rate of free air detection was higher when compared with perforations that were not related to an implant (57.1%), but this was not significant (Table 4). Interestingly, in perforations secondary to a tumor

Table 2. Etiological factors and mortality/morbidity rates

	Total patients (n=59)	Major complication (n=10)	Mortality (n=4)
Etiology, n (%)			
Adhesion	12 (20.3%)	2	4 (100%)
Tumor implant	10 (16.9%)	0	0
Herniation	9 (15.3%)	4	0
IBD	6 (10.2%)	0	0
Foreign body	4 (6.8%)	0	0
Other	4 (6.8%)	2	0
Ischemia	4 (6.8%)	2	0
Tuberculosis	2 (3.4%)	0	0
Idiopathic	2 (3.4%)	0	0
Lymphoma	2 (3.4%)	0	0
Diverticulitis	2 (3.4%)	0	0
Phytobezoar	2 (3.4%)	0	0

IBD: Inflammatory bowel disease

Table 3. Analysis of the computerized tomography data of the subgroups stratified by complication, presence of malignancy and age

	Total patients (n=59)	No complications (n=49)	Complications present (n=10)	p	No history of malignancy (n=35)	History of malignancy present (n=24)	p	Younger than 65 years (n=28)	Older than 65 years (n=31)	p
Intra-abominal free air, (n, %)	36 (61)	28 (57.1)	8 (80)	0.288	16 (45.7)	20 (83.3)	**0.004***	18 (64.3)	18 (58.1)	0.625
Intra-abdominal free fluid, (n, %)	57 (96.6)	49 (100)	8 (80)	**0.026***	33 (94.3)	24 (100)	0.509	28 (100)	29 (93.5)	0.493
Bowel wall thickening, (n, %)	51 (86.4)	43 (87.8)	8 (80)	0.613	29 (82.9)	22 (91.7)	0.453	26 (92.9)	25 (80.6)	0.259
Loss of wall integrity, (n, %)	18 (30.5)	16 (32.7)	2 (20)	0.708	12 (34.3)	6 (25)	0.447	8 (28.6)	10 (32.3)	0.759
Abnormal wall enhancement, (n, %)	12 (20.3)	10 (20.4)	2 (20)	1.000	12 (34.3)	0	**0.001***	4 (14.3)	8 (25.8)	0.272
Infiltration of adjacent fat planes, (n, %)	55 (93.2)	47 (95.9)	8 (80)	0.130	33 (94.3)	22 (91.7)	1.000	26 (92.9)	29 (93.5)	1.000
Phlegmon and abscess, (n, %)	16 (27.1)	12 (24.5)	4 (40)	0.436	8 (22.9)	8 (33.3)	0.374	8 (28.6)	8 (25.8)	0.811
Increase in small bowel diameter, (n, %)	43 (72.9)	37 (75.5)	6 (60)	0.436	29 (82.9)	14 (58.3)	**0.037***	20 (71.4)	23 (74.2)	0.811
Small bowel diameter (mm), median (Q1-Q3)	37 (34-40)	37 (34-40)	54 (32-73)	0.104	38 (33-40)	37 (34-42)	0.696	38.5 (35-42)	34 (32-40)	**0.018***

Fischer's exact test was used. n: Number of patients, mm: Millimeter, p: p-value, Complication: Major complications (CDC 3 and 4)

Table 4. Analysis of CT data of patients with a history of chemotherapy and perforations resulting from a tumor implant

	No chemotherapy (n=45)	Received chemotherapy (n=14)	p	No tumor implant (n=49)	Tumor implant present (n=10)	p
Intra-abdominal free air, (n, %)	24 (53,3)	12 (85,7)	0,030*	28 (57,1)	8 (80)	0.288
Intra-abdominal free fluid, (n, %)	43 (95,6)	14 (100)	1,000	47 (95,9)	10 (100)	1.000
Bowel wall thickening, (n, %)	39 (86,7)	12 (85,7)	1,000	43 (87,8)	8 (80)	0.613
Loss of wall integrity, (n, %)	16 (35,6)	2 (14,3)	0,189	14 (28,6)	4 (40)	0.475
Abnormal wall enhancement, (n, %)	12 (26,7)	0	0,052	12 (24,5)	0	0.105
Infiltration of adjacent fat planes, (n, %)	43 (95,6)	12 (85,7)	0,236	47 (95,9)	8 (80)	0.130
Phlegmon or abscess, (n, %)	10 (22,2)	6 (42,9)	0,172	16 (32,7)	0	**0.049***
Increase in small bowel diameter, (n, %)	37 (82,2)	6 (42,9)	0,013*	37 (75,5)	6 (60)	0.436
Major complication, (n, %)	8 (17,8)	2 (14,3)	1,000	10 (20,4)	0	0.186
Mortality, (n, %)	4 (8,9)	0	0,564	4 (8,2)	0	1.000

Fischer's exact test was used. n: Number of patients, mm: Millimeters, p: p-value, CT: Computerized tomography

implant, the rate of intra-abdominal abscess/phlegmon was significantly lower and major complications also occurred at lower rates, however this was not significant (Table 4). Similarly to patients who received chemotherapy, abnormal wall enhancement was less evident in perforations related to a tumor implant.

Discussion

SBPs are among the rare causes of a clinical picture of an acute abdomen and the etiology may be wide-ranging.[5] Traumatic perforations of the small bowel are more frequent than non-traumatic perforations.[6] Although there is an increasing amount of published data regarding SBP, there remains a paucity of data about non-traumatic perforations localized in the small bowel that are not accompanied by other organ injuries. Early detection and quick surgical treatment are essential to reduce morbidity and mortality.[7] In contrast with gastroduodenal perforation, extraluminal gas is either found at low amounts or not found at all in SBPs.[8] This complicates the diagnosis and prolongs the treatment time. In patients with a clinical picture of an acute abdomen, typically an abdominal CT is requested first as a diagnostic imaging method and this is clinically useful in the diagnosis of SBP.[5] Our study did not include traumatic SBPs and only patients with non-traumatic perforations were enrolled, which resulted in a limited number of patients in our study. In line with the literature, a full abdominal CT was performed in patients with the clinical picture of an acute abdomen in our clinic in consideration of SBP and other differential diagnoses.

Previous publications have reported the associated mortality rates to be as high as 40%.[9] Although mortality rates are gradually decreasing due to the broader opportunities for a quick diagnosis and early treatment with the advances in imaging methods, the improvements in the surgical technique, appropriate antimicrobial treatment and perioperative intensive care support, they remain high. The mortality rate was 19.1% in a study conducted in Singapore.[10] In our patient series, the mortality rate was 6.8%, which is at an acceptable level when compared to the literature. When clinical characteristics of the patients were examined, there were no factors with a significant influence on 30-day peri-operative mortality. This was attributed to the low number of total patients and mortality cases in our patient series.

When the underlying etiological causes were investigated, the most common causes were adhesions, IBD and infectious diseases. Perforations secondary to tumor implants are encountered rarely and have previously mostly been published as case reports.[11,12] The most common cause was also adhesion in our study and this was followed by perforations related to malignant metastatic implants. Particularly, bowel metastasis from lung cancer was reported to be associated with a high incidence, varying between 2-14% in autopsy studies, in contrast with that previously known.[11] SBPs related to metastatic non-small cell lung cancer occur in patients in advanced stages and very rarely. Aggressive surgery may provide effective palliation but the overall prognosis of the disease is poor.[11] In our patient group, small bowel metastases related to tumors occurred at a rate of 16.9%, which is high when compared with the literature. In total, perforations secondary to tumor implants were detected in 10 of our patients; seven of these (70%) were metastases from lung cancer.

In contrast, lymphomas of the small intestine are rare and comprise approximately 1% of malignant gastrointestinal tumors. Non-Hodgkin lymphoma is encountered the most commonly. Cases of lymphoma of the small intestine have been reported in the literature, but emphasis on emergency surgery is extremely uncommon.[13] Our results included two patients with perforations caused by intestinal cancer and the primary was small bowel lymphoma of the non-Hodgkin subtype in both cases. By means of a quick diagnosis, perioperative mortality did not occur in either patient.

In SBP, which is an aggressive disease, the most vital factors in reducing mortality and morbidity are an early diagnosis and a quick surgical treatment.[7] We believe that the fact that all patients with the picture of an acute abdomen were able to immediately undergo a CT (a separate tomography device is dedicated for the use of emergency services) made an early diagnosis and treatment possible, culminating in the low mortality rate. Lung radiographs typically do not show pneumoperitoneum. Tan et al.[10] detected free air in the lung radiographs of only 23.4% of the patients in their patient group. Therefore, they reported adopting CT scans in the evaluation of patients presenting to their institution with an acute abdomen and performing CT scans in 68.1% of their patients.[10]

In the case of SBP, CT findings are usually non-specific but when present, they may be helpful for the radiologist in identifying a specific cause for the perforation.[5] When compared with plain abdominal X-rays, CT is more sensitive in identifying small amounts of free air.[13] Direct CT findings of bowel perforations are: Free gas in the abdominal cavity; visible transmural lesion of bowel wall; and extraluminal leakage of orally administered contrast material.[14,15] Notably, in some clinics, oral contrast material is not used for these indications[13] and thus this CT indication would not be present. Meanwhile, indirect CT findings of bowel perforations include misty mesentery, free fluid in the abdominal cavity, bowel wall thickening and extraluminal fecal matter.[15] While free air is not usually found in SBPs, free fluid represents an important finding of intestinal damage when associated with the suspicion of perforation.[16]

Our results determined intra-abdominal free air in 61% of the patients and bowel wall thickening in 86.7% of the patients. Meanwhile, intra-abdominal free fluid was present in 96.6%, which is extremely high. Loss of bowel wall integrity was reported in only 30.5% of the patients. Increases in small bowel diameter were found at significantly higher rates in the group that did not receive chemotherapy and did not have a history of malignancy (Table 4). As a reason for this, it was considered that a decision on emergency surgery could be made earlier, since bowel perforations have a more eventful course and manifest symptoms more quickly in groups that have a history of malignancy and that received chemotherapy. Thus, ileus and bowel dilation, which are later findings, may have occurred less frequently due to early surgery.

When the CT findings were examined, free air on CT was found at a higher rate in perforations related to tumor implants compared with other perforations (80% vs 57%) but this was not found to be significant. Interestingly, the rate of intra-abdominal abscess/phlegmon in perforations related to implants was significantly lower. In the same way, major complications also occurred at lower rates, although this was not significant. Similarly to patients who received chemotherapy, abnormal wall enhancement was present at a lower rate in perforations related to tumor implants. This might be because intra-abdominal air is encountered more frequently in perforations related to implants and a perforation is suspected at earlier stages.

For treatment, a small bowel resection was performed on most of the patients, and creating a stoma was found to be associated with poorer clinical outcomes.[10] In our practice, resection + anastomosis (83.1%) was also the most commonly preferred method. In line with the literature, performing an ileostomy was found to be significantly associated with the occurrence of major complications. This was probably because ileostomy was preferred in patients with more aggressive findings, who were not appropriate for anastomosis (presence of extensive intra-abdominal abscess, a condition of fecal peritonitis and presence of other gross pathologies).

Study Limitations

The limitations of our study include its retrospective design, the limited number of patients due to the exclusion of patients with traumatic SBPs and SBPs accompanied by additional organ injuries.

Conclusion

In conclusion, early diagnosis and treatment play a vital role in reducing the mortality and morbidity associated with SBP. Thus, CT might serve as the biggest guide for the surgeon in patients with a clinical picture of an acute abdomen that are suspected of having SBPs. SBP should be considered in the differential diagnosis in the case of patients with lung cancer who manifest a clinical picture of an acute abdomen.

Ethics

Ethics Committee Approval: Approval for this study was obtained from the University of Health Sciences Turkey, İzmir Tepecik Training and Research Hospital Clinical Research Ethics Committee (approval number: 2021/06-37).

Informed Consent: Retrospective study.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.D., Ke.T., Ko.T., Concept: A.D., G.Y.O., Design: A.D., G.Y.O., Ko.T., Data Collection or Processing: A.D., Ko.T., Analysis or Interpretation: A.D., G.Y.O., Ke.T., Ko.T., Literature Search: A.D., G.Y.O., Writing: A.D., G.Y.O., Ke.T., Ko.T.

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