Nonoperative Management of Patients With a Diagnosis of High-grade Small Bowel Obstruction by Computed Tomography

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Objective: To determine the natural history and treatment of high-grade small bowel obstruction (HGSBO). Small bowel obstruction is a frequent complication of abdominal surgery. Complete and strangulating obstructions are managed operatively while partial obstructions receive a trial of nonoperative therapy. The management and outcome of patients with HGSBO diagnosed by computed tomography (CT) has not been examined.

Design: Retrospective medical record review. Outcomes for nonoperative vs operative management were analyzed using Fisher exact and log-rank tests.

Setting: Tertiary care referral center.

Patients: One thousand five hundred sixty-eight consecutive patients admitted from the emergency department with a diagnosis of small bowel obstruction between 2000 and 2005 by CT criteria.

Main Outcome Measures: Recurrence of symptoms and complications.

Results: One hundred forty-five patients (9%) with HGSBO were identified, with 88% follow-up (median, 332 days; range, 4-2067 days). Sixty-six (46%) were successfully managed nonoperatively while 79 (54%) required an operation. Length of stay and complications were significantly increased in the operative group (4.7 days vs 10.8 days and 3% vs 23%; \( P < .001 \)). Nonoperative management was associated with a higher recurrence rate (24% vs 9%; \( P < .005 \)) and shorter time to recurrence (39 days vs 105 days; \( P < .005 \)) compared with operative intervention. Computed tomography signs of ischemia, admission laboratory results, and presence of cancer or inflammatory bowel disease were not predictive of an operation.

Conclusions: Patients with HGSBO by CT can be managed safely with nonoperative therapy; however, they have a significantly higher rate of recurrence requiring readmission or operation within 5 years.

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MALL BOWEL OBSTRUCTION (SBO) is a common consequence of abdominal surgery accounting for 15% of surgical admissions to US hospitals. It is caused by peritoneal adhesions in 50% to 80% of cases while other causes reported in retrospective studies include neoplastic disease (ovarian, pancreatic, gastric, colorectal), hernias (inguinal, umbilical, ventral, internal, obturator), inflammatory bowel disease (IBD), intestinal volvulus or malrotation, and other miscellaneous causes (abscess, intussusception, bazoar, gallstone ileus).1 The cost of hospital treatment and management of SBO has been estimated to be greater than $1 billion per year.2 The typical therapeutic algorithm involves the differentiation of mechanical obstruction from paralytic ileus followed by determination of partial vs complete obstruction and lastly by discrimination between simple or strangulating obstruction. The identification of mechanical obstruction can usually be ascertained by a thorough history of presenting symptoms, physical examination findings, and plain radiographs of the abdomen. The differentiation between partial and complete obstruction can be more challenging because it relies on the patient's recollection of passage of flatus or stool.

See Invited Critique

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Oral and intravenous contrast-enhanced computed tomography (CECT) has been used more frequently to distinguish between partial and complete SBO by identifying the amount of residual air and fluid in the collapsed distal bowel segments.3 This differentiation is critical because partial obstructions, which are usually man-

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aged nonoperatively, rarely cause bowel strangulation while complete obstructions are associated with a 20% to 40% incidence of strangulation and are therefore managed operatively.1

However, early complete obstructions can be difficult to distinguish from partial high-grade obstruction by conventional clinical criteria. Since reversible signs of strangulation are not reliable, these patients are at a considerable risk for significant morbidity and mortality if misdiagnosed.4 Contrast-enhanced computed tomography has been reported to be the most sensitive modality for diagnosing an SBO compared with plain radiographs or enteroclysis.5 In addition, CECT can be extremely useful in providing the location and cause of the obstruction, the presence of a transition point, and signs of strangulation, such as bowel wall thickening, interloop fluid, and lack of mucosal enhancement.6 However, the contribution of computed tomography (CT) diagnosis of high-grade SBO (HGSBO) to clinical decision making and the natural history of HGSBO has never been examined. Therefore, the purpose of this study was to determine if CECT identification of an HGSBO contributed to the management and outcome of these patients.

METHODS

We retrospectively reviewed the medical and electronic records of all patients admitted to Brigham and Women’s Hospital between 2000 and 2005 with a diagnosis of SBO confirmed by CECT in the emergency department. The search was conducted using the International Classification of Diseases, Ninth Revision codes for SBO (560, 560.8, and 560.9) using the Research Depository of Patient Records, a database that stores each patient’s clinical information abstracted from his or her medical record. Once identified, only patients who had demonstrated HGSBO by CECT as determined by an attending radiologist’s interpretation were included for further investigation. This included all patients whose reports contained the words “suspicious,” “indicative,” or “suggestive” of an HGSBO. The study was approved by the institutional review board and the Brigham and Women’s Hospital Committee for the Protection of Human Subjects.

The records of all patients with HGSBO by CECT were reviewed for demographic data, comorbid disease (IBD, history of abdominal cancer or radiation), number and type of previous surgeries, etiology and interval of previous obstructions, admission vital signs, laboratory results, and presence of CT signs of ischemia (eg, ascites, bowel wall thickening, lack of mucosal enhancement, pneumatosis). Patients were stratified into 3 different treatment algorithms: nonoperative management only, trial of nonoperative management followed by surgeon’s decision to operate, or immediate operative intervention. Nonoperative management consisted of nasogastric decompression, intravenous fluid resuscitation, and correction of electrolyte levels. For patients who underwent surgery, indication for surgery, time to operation, and length and type of procedure were recorded. The primary end point was recurrence of SBO requiring admission to the hospital while secondary end points included length of stay, complications (wound infection, intensive care unit admission, bowel ischemia, postoperative ileus), and mortality.

Statistical analysis was performed by a commercial software program (Stata 7.0; StataCorp, College Station, Texas) using Mann-Whitney and χ² tests with a Fisher exact test for continuous and categorical variables, respectively. The primary end point was calculated using the Kaplan-Meier method and differences were analyzed with the log-rank test. Predictive factors were analyzed by logistic regression. A 2-tailed P value <.05 was considered significant.

RESULTS

Of 1568 admissions for SBO through the emergency department during the 5-year study period, 145 (9%) were determined to have HGSBO by CECT. Typical CT findings of HGSBO are exemplified in Figure 1. Nonoperative management was attempted in 104 patients; however, 38 patients required an operation (25 for failure of symptom resolution, 10 for worsening clinical examination findings, and 3 for other reasons), leaving a cohort of 66 patients who did not undergo an operation. On the other hand, 41 patients were taken to the operating room as the initial intervention, for a total of 79 patients who were managed surgically. The median follow-up period was 332 days (range, 4-2067 days).

Patients’ demographic information is summarized in Table 1. The only significant difference between patients managed nonoperatively and surgically was age (61 years vs 54 years; P < .02). Previous surgery, number of postoperative obstructive episodes (within 30 days of index abdominal surgery), and presence of IBD, abdominal cancer, or radiation exposure were not different between groups.

![Image](https://via.placeholder.com/150)

Figure 1. Typical computed tomography findings of high-grade small bowel obstruction (HGSBO). A, Computed tomography findings of HGSBO include a transition point (white arrow) and dilatation of small bowel (white bar). B, Patient with HGSBO and computed tomography signs of ischemia (white arrow) who was managed nonoperatively.
For those patients who were initially managed nonoperatively followed by surgery, the mean interval to operative intervention was 68 hours 45 minutes (range, 6 hours 6 minutes to 211 hours 34 minutes) vs 12 hours 33 minutes (range, 1 hour 42 minutes to 28 hours 19 minutes) for those who were immediately taken to surgery. The former time included the preoperative observation period. There was no statistically significant difference in the duration of the operation between the delayed and immediate surgery groups (2 hours 3 minutes vs 2 hours 5 minutes; \( P > .99 \)). In addition, there was no statistically significant difference in the number of patients who had a lysis of adhesions (delayed surgery, 71% vs immediate surgery, 61%; \( P < .47 \)) or required a bowel resection (delayed surgery, 39% vs immediate surgery, 49%; \( P < .50 \)) or reduction of hernia (delayed surgery, 24% vs immediate surgery, 27%; \( P < .80 \)). Furthermore, between the 2 operative groups, delayed and immediate, there was no statistically significant difference in length of stay (11.6 days vs 10.5 days; \( P < .79 \)) or complications (24% vs 22%; \( P > .99 \)) (Table 2). However, compared with patients who were managed nonoperatively, patients who underwent surgery (immediate or delayed) had a statistically significant increase in length of stay (4.7 days vs 10.8 days; \( P < .001 \)) and complications (3% vs 23%; \( P < .001 \)).

There were 4 deaths in the study cohort. 2 in the operative group and 2 in the nonoperative group. The latter 2 were due to a family decision to make the patient comfortable and forgo surgical measures because of advanced neoplastic disease and grim prognosis. One death in the operative group was due to intestinal ischemia requiring massive enterectomy in an 81-year-old patient with end-stage renal disease who developed multiorgan system failure while the other was an 83-year-old patient with previous low anterior resection who developed a complete obstruction from an internal hernia and died of respiratory failure despite maximal intervention.

Interestingly, none of the classic signs of strangulation, including fever higher than 38°C, tachycardia with a heart rate more than 100 beats/min, white blood cell count higher than 10,000/µL (to convert to \( \times 10^9/\text{L} \), multiply by 0.001), acidosis defined by anion gap more than 12 mEq/L (to convert to millimoles per liter, multiply by 1), or presence of CT signs of ischemia, were predictive of need for surgery (Table 3).

Recurrence was the primary end point of the study and is outlined in Figure 2. Compared with surgical intervention, nonoperative management was associated with a significant increase in the number of readmissions for recurrence (24% vs 9%) and a shorter time to recurrence (mean, 39 days vs 105 days; \( P < .005 \)).

**Table 1. Patient Demographics**

<table>
<thead>
<tr>
<th></th>
<th>Nonoperative (n=66)</th>
<th>Surgery (n=79)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>40 (61)</td>
<td>52 (66)</td>
<td>.51</td>
</tr>
<tr>
<td>Age, y, mean</td>
<td>60.8</td>
<td>54.4</td>
<td>.02</td>
</tr>
<tr>
<td>Prior surgeries, mean</td>
<td>1.7</td>
<td>1.6</td>
<td>.65</td>
</tr>
<tr>
<td>No prior surgery</td>
<td>8 (12)</td>
<td>11 (14)</td>
<td>.59</td>
</tr>
<tr>
<td>Postoperative obstructive episode(s) within 30 d</td>
<td>14 (21)</td>
<td>14 (17)</td>
<td>.67</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>8 (11)</td>
<td>6 (7)</td>
<td>.41</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>8 (11)</td>
<td>9 (11)</td>
<td>.97</td>
</tr>
<tr>
<td>Inflammatory bowel disease</td>
<td>4 (6)</td>
<td>6 (8)</td>
<td>.72</td>
</tr>
<tr>
<td>Abdominal cancer</td>
<td>19 (27)</td>
<td>19 (24)</td>
<td>.66</td>
</tr>
<tr>
<td>Radiation therapy</td>
<td>9 (13)</td>
<td>6 (8)</td>
<td>.36</td>
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</tbody>
</table>

**Table 2. Surgical Outcomes**

<table>
<thead>
<tr>
<th></th>
<th>Immediate Surgery (n=41)</th>
<th>Delayed Surgery (n=38)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval to operating room</td>
<td>12 h 33 min 26 s</td>
<td>68 h 45 min 13 s</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Operative time</td>
<td>2 h 5 min 29 s</td>
<td>2 h 3 min 40 s</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>Length of stay, d, mean</td>
<td>10.5</td>
<td>11.6</td>
<td>&lt;.79</td>
</tr>
<tr>
<td>Lysis of adhesions</td>
<td>25 (61)</td>
<td>27 (71)</td>
<td>&lt;.47</td>
</tr>
<tr>
<td>Bowel resection</td>
<td>20 (49)</td>
<td>15 (39)</td>
<td>&lt;.50</td>
</tr>
<tr>
<td>Hernia reduction</td>
<td>11 (27)</td>
<td>9 (24)</td>
<td>&lt;.80</td>
</tr>
<tr>
<td>Complications</td>
<td>9 (22)</td>
<td>9 (24)</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>Mortality</td>
<td>2 (5)</td>
<td>0</td>
<td>.49</td>
</tr>
</tbody>
</table>

**Table 3. Factors Predictive of Surgery**

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever &gt;38°C</td>
<td>0.65 (0.17-2.52)</td>
<td>.53</td>
</tr>
<tr>
<td>Tachycardia, heart rate &gt;100 beats/min</td>
<td>1.51 (0.75-3.05)</td>
<td>.25</td>
</tr>
<tr>
<td>WBC count &gt;10,000/µL</td>
<td>0.99 (0.51-1.90)</td>
<td>.97</td>
</tr>
<tr>
<td>Acidosis, anion gap &gt;12 mEq/L</td>
<td>1.48 (0.60-3.65)</td>
<td>.39</td>
</tr>
<tr>
<td>CT signs of ischemia</td>
<td>0.99 (0.46-2.12)</td>
<td>.98</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; CT, computed tomography; OR, odds ratio; WBC, white blood cell.

SI conversion factor: To convert anion gap to millimoles per liter, multiply by 1; WBC count to \( \times 10^9/\text{L} \), multiply by 0.001.

The appropriate triage of patients in the setting of SBO can be challenging. While radiography would have been the mainstay of imaging for this disease a decade or more ago, the technological advancement in CT has yielded a greater sensitivity and specificity for diagnosing a high-grade or complete obstruction to 82% to 100%.7 The purpose of this study was to examine if the determination of HGSBO by CT should alter patient management with regard to timing of operative intervention and if this decision would affect time to recurrence. A diagnosis of bowel obstruction is suspected on CT when proximal bowel distention of greater than 25 mm is associated with collapsed distal bowel loops. The transition point in bowel diameter is judged to be the site of obstruction. A low-grade or partial obstruction is suggested when contrast material reaches a transition point without significant delay and passes through the obstruction to a degree that mucosal folds in the distal bowel are recognizable. On the other hand, a high-
grade obstruction is entertained when there is a delay or absence in the transit of contrast material through an obstruction site wherein only a small amount or no contrast material reaches collapsed loops of bowel distal to the obstruction site. Other criteria often used to describe high-grade obstruction include the beak sign, where the bowel narrows to a beak at the transition point, which is present in 60% of cases. In addition, the “string of pearls” and “small bowel feces” signs, which arise from the mixing of air and enteric contents in stasis, are present in 80% of patients with HGSBO. One of the most important contributions of CT is the determination of intestinal ischemia from strangulating obstructions. While some radiographic features such as thickened bowel wall, submucosal edema, and ascites can be nonspecific, others such as lack of contrast enhancement can be highly suggestive of ischemia.

Once the diagnosis of SBO is made, proper management depends on the nature of the obstruction. While partial obstructions can be managed conservatively with nasoenteric decompression and hydration for a period of several days, patients with complete obstructions with signs of strangulation should undergo exploration after a period of resuscitation. Previous retrospective studies have suggested that conservative management can be successful in 65% to 80% of cases of partial SBO. Some authors have even suggested a 37% resolution rate in patients with complete obstructions. In our study of only HGSBO, we noted a 43% success rate of conservative management. We found no difference in medical comorbidities, number of previous surgeries, or early postoperative bowel obstructions (EPSBOs) between the nonoperative group and the operative group. In addition, primary SBOs were not different among groups, even though those from suspected internal hernias are usually managed surgically given the high likelihood of strangulation. On the other hand, those due to carcinomatosis are preferentially managed conservatively given their low potential for strangulation. Other causes of primary intestinal obstruction such as radiation or IBD did not seem to contribute to a need for an operation in our population of HGSBO. This is consistent with previous studies that have demonstrated similar findings in patients with partial SBOs. Early postoperative bowel obstruction is a complicated disease process and a topic of much debate among gastrointestinal surgeons. While it is possible to distinguish EPSBO from ileus in the postoperative setting, there is considerable debate as to how to manage it. Since most EPSBOs are not strangulating, there is a tendency to manage them nonoperatively. The most difficult decision is how long to defer surgical intervention in patients who do not gain resolution of bowel function. This notion was highlighted in our study because there was no clear preference for surgical or nonoperative management of HGSBO from EPSBO. The only predictor of nonoperative therapy was older age. This may be due to an inherent bias of this retrospective study as younger patients may have been perceived to be more fit for an operation. However, Fenvang et al have suggested that older age, independent of comorbid conditions, is a predictive factor for higher complications and death in patients undergoing surgical correction of SBO.

The rest of the patients either underwent an immediate operation or had an initial trial of conservative therapy fail and required a delayed operation. The mean elapsed time from CT diagnosis to operation in the immediate surgery group was 12 hours 33 minutes, well within established clinical guidelines for aggressive resuscitation prior to surgery. On the other hand, conservative management has been advocated for a period of up to 5 days and the mean interval to intervention in our nonoperative trial group was 68 hours 43 minutes. Delayed operation was not associated with an increased risk of strangulation because there was no statistical difference between the need for a bowel resection or complications between the immediate or delayed groups. This finding was in contradiction to previous studies that demonstrated an increased rate of strangulation in patients undergoing early operation for SBO. The authors of that study concluded that this was due to accurate preoperative diagnosis of strangulation. In our study, the length of stay and complication rate were not different between the delayed and immediate operation groups, suggesting that a trial period of conservative management may be warranted in patients with HGSBO without suspected signs of strangulation. The only deaths in the operative cohort were in the immediate surgery group, due to advanced comorbid disease, and would have likely not been preventable.

Traditional signs of strangulation, such as acidosis, leukocytosis, fever, and tachycardia, in addition to CT signs of ischemia were not predictive of operative intervention in our population, suggesting that they may not be reliable indicators of bowel ischemia in HGSBO. Our finding was consistent with Sarr et al, who reported that none of these clinical parameters were either sensitive or specific for the preoperative detection of strangulation in complete bowel obstructions.

Recurrence of obstructive symptoms requiring readmission was the primary end point of the study and our data indicate that conservative management of HGSBO was associated not only with a higher recurrence rate but also with a shorter time to recurrence. This finding was supported by Barkan et al and Williams et al, who found lower recurrences in surgically managed patients. In contrast, Miller et al found no difference in recurrent obstructions between patients managed conservatively or...
after an operation. The discrepancy may be due in part to the different definitions used in the literature for recurrence and possibly due to lack of long-term follow-up of these patients. This is certainly one of the limitations of our study. The largest retrospective study in the literature examined the clinical course of 32,583 patients with SBO using data collected by the California Office of Statewide Health Planning and Development for 5 years.16 Their results indicate that after index admission for SBO, patients who were managed operatively had a 16% recurrence rate compared with 20% for those managed medically and had a longer time to recurrence (354 days vs 197 days). The major limitation of this study was that specific clinical data regarding degree of obstruction and etiology were not available. In another large retrospective study, Duron et al18 prospectively followed up 500 patients who had an operation for SBO with a median follow-up of 10 years and noted a recurrence rate of 18%. While surgery decreased readmissions, it did not prevent the need for future surgery for SBO. In a more recent multicenter study, Duron et al18 prospectively followed up 286 patients who had an operation for SBO over a 3-year period with a mean follow-up of 40 months in which they found an overall recurrence rate of 12%. However, this study only included patients with adhesive disease from previous abdominal surgery and excluded patients with intraperitoneal cancer, radiation, or IBD, thus limiting this study’s generalizability to the larger SBO population.

In summary, the advent of CT has heralded a new era of abdominal imaging whereby the degree, location, and radiographic features of SBO can be evaluated. Precise determination of strangulation both clinically and radiographically in HGSBO continues to be a challenge. Our data suggest that nearly half of patients with a diagnosis of HGSBO by CT can be safely managed nonoperatively as long as no evidence of strangulation is present; however, nonoperative management was associated with a higher and more frequent rate of SBO recurrence requiring readmission within 5 years.

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Author Contributions: Study concept and design: Rocha, Zinner, and Ferzoco. Acquisition of data: Rocha, Theme, and Zinner. Analysis and interpretation of data: Rocha, Matros, Ledbetter, Zinner, and Ferzoco. Drafting of the manuscript: Rocha and Zinner. Critical revision of the manuscript for important intellectual content: Rocha, Theme, Matros, Ledbetter, Zinner, and Ferzoco. Statistical analysis: Rocha, Matros, and Zinner. Obtained funding: Zinner. Administrative, technical, and material support: Zinner. Study supervision: Zinner and Ferzoco.

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REFERENCES