Obstruction reduction: Use of water-soluble contrast challenge to differentiate between partial and complete small bowel obstruction

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ABSTRACT

Differentiating SBO that will resolve conservatively from those requiring surgery remains challenging. Water-soluble contrast administration may be diagnostic and therapeutic. Our study evaluated use of a WSC challenge protocol. We hypothesize that protocol use discriminates between surgical SBO and obstructions which can be managed non-operatively.

Demographics, prior surgeries, time to operation, complications, and LOS were analyzed.

108 patients were admitted with SBO. 13% underwent immediate laparotomy with concern for bowel compromise; these had a median LOS of 8.5 days. 91 received WSC protocol. Of these, 77% had contrast passage to the colon. Of the 48 in whom contrast passed between 0 and 12 h, LOS was 2 days. Of the 22 patients in whom contrast passed between 12 and 24 h, LOS was 4.5 days. 21 had failure of contrast passage; 18 of those underwent surgery after 24 h as a result. Of the 21 patients who failed WSC challenge, median LOS was 8 days.

WSC protocol implementation facilitates early recognition of partial from complete obstruction and may decrease LOS. Our findings warrant further evaluation with a multicenter trial.

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Background

The incidence of adhesive small bowel obstruction (SBO) following abdominal operation is 2.5%.[1] In North America, there are more than 300,000 annual hospital admissions for SBO which accounts for 850,000 days of inpatient care, and $2.7 billion in medical expenditures.[2] Early differentiation between SBOs more likely to resolve with conservative management versus those that will require surgical intervention remains challenging.[2] Contrast imaging is often performed for both diagnostic and therapeutic reasons, with some centers having successfully implemented standardized protocols for the management of SBO using contrast challenges.[3] (see Fig. 1)

For those patients who will ultimately require an operation, timely intervention is paramount. One study found increased overall 30-day morbidity in patients who underwent surgical exploration for obstructive disease after a length of stay (LOS) of 3 days as compared to those who underwent operation earlier in their hospitalization.[4] The 2013 World Society of Emergency Surgery Guidelines (Bologna Guidelines) for the management of SBO recommend surgical intervention be pursued, or WSC study be performed after 3 days if there is no resolution.[5] The EAST guidelines recommend consideration of water soluble contrast (WSC) in patients who do not demonstrate clinical resolution after 48 h.[6]

Hypertonic WSC agents may be therapeutic, as they draw fluid into the lumen of the bowel, thereby decreasing intestinal wall edema and stimulating peristalsis.[7] Abdominal radiographs can subsequently evaluate for contrast passage to the colon following administration; hence WSC may also be diagnostic. Contrast passage, combined with pain abatement, are indications that the patient's diet can be advanced, and disposition plans can be considered. However, failure of WSC to reach the colon within 24 h of ingestion suggests an obstruction necessitating operative intervention.[8]

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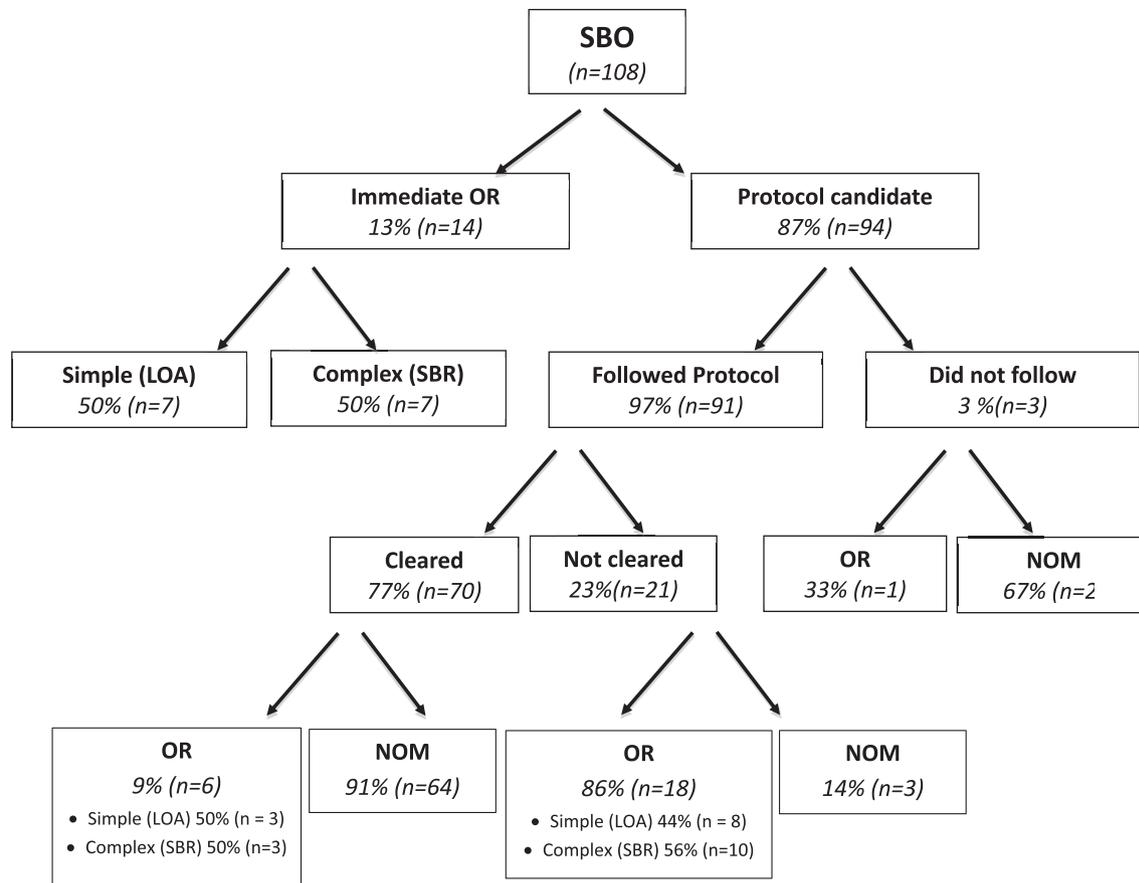E-mail address: Eric.Campion@dhha.org (E.M. Campion).

Fig. 1. Patient algorithm.

Previous groups have demonstrated the utility of WSC protocol in the diagnosis and treatment of SBO, and found that implementation of WSC protocols did not increase length of stay, morbidity, or mortality.[3] The purpose of this study is to evaluate the efficacy of and any complications associated with our institutions' use of a SBO protocol using WSC challenge. We hypothesized that use of a protocol involving WSC challenge will facilitate differentiation between surgical SBO and obstructions that can be managed non-operatively.

Methods

A protocol was implemented at two tertiary care centers in July 2016. Patients admitted to the Trauma and Acute Care Surgery (TACS) service with a SBO between July 1, 2016–June 30, 2017 were identified. Laboratory data including complete blood count, basic metabolic panel, and venous lactate was obtained in the Emergency Department. Patients were taken immediately to the operating room if they demonstrated peritonitis, if there was a high clinical suspicion of bowel compromise, or CT demonstrated concern for bowel compromise or perforation. For CT findings of mesenteric edema, pneumatosis, free fluid, suspicion for closed-loop obstruction, or "whirlpool" or swirl sign, the decision to proceed to surgery versus administration of WSC protocol was determined by the attending surgeon based on clinical findings.

WSC Protocol: Following at least 6 h of nasogastric tube decompression, patients received 120 ml of undiluted WSC via nasogastric tube (NGT), which was subsequently clamped. If the patient developed nausea or increasing abdominal pain, the NGT was unclamped and the patient re-assessed by the surgical team.

Plain radiographs were taken at 12 and 24 h after contrast administration to evaluate for contrast passage to the colon. Failure of contrast passage after 24 h was considered a relative indication for surgery. Increased abdominal pain, and worsening leukocytosis during protocol administration were considered relative indications for surgery, while development of peritonitis during protocol administration was considered an absolute indication for surgery.

After institutional review board approval, we retrospectively collected data from all patients presenting with a small bowel obstruction to the surgical services. Demographics, prior surgical history, time to operation, postoperative complications, and hospital length of stay were reviewed. Statistical analysis was performed using Chi Squared or Fischer's exact test where appropriate for categorical variables. The Kruskal-Wallace nonparametric test was used to analyze continuous variables. A p value ≤ 0.05 was considered significant. Data was collected and managed with Microsoft Excel 8.0 (Microsoft, Redmond, WA). All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC).

Results

During the 1 year study, 130 patients were admitted with a SBO. Twenty patients were admitted to a non-surgical service and were excluded from our analysis. Of the one-hundred and ten patients admitted to the surgical service, two patients refused treatment, and were excluded from analysis (Figure 1).

Of the 108 patients included in the study (Table 1), 13% (n = 14) underwent immediate laparotomy because of concern for bowel compromise. Of these, 7 required adhesiolysis alone while 7

Table 1
Patient demographics and characteristics.

	Underwent protocol n = 91	Straight to OR n = 14	P-value
Age	55.0 (39.0–68.0)	58.0 (43.0–68.0)	0.60
BMI	25.2 (22.0–31.3)	22.4 (18.9–28.6)	0.08
Number of comorbidities[a]	1.0 (0.0–2.0)	3.0 (1.0–4.0)	<0.01
Number of complications on CT	0.0 (0.0–2.0)	1.0 (0.0–2.0)	0.13
Sex			0.49
Male	52.7% (48)	42.9% (6)	
Female	47.3% (43)	57.1% (8)	
History of SBO	39.6% (36)	28.6% (4)	0.43
Leukocytosis (WBC >11,000) on admission	35.2% (32)	28.6% (4)	0.77
Lactate elevation (>2.2) on admission	29.9% (23)	23.1% (3)	0.75
Acidosis (Bicarbonate <21) on admission	13.3% (12)	35.7% (5)	0.05
CT: Free fluid	20.2% (18)	28.6% (4)	0.49
CT: wall thickening	10.1% (9)	7.1% (1)	>0.99
CT: closed loop	4.5% (4)	21.4% (3)	0.05
CT: Swirl sign	3.4% (3)	14.3% (2)	0.14
CT: Other CTS Complication	32.6% (29)	57.1% (8)	0.08
Hospital length of stay	3.0 (2.0–7.0)	8.5 (7.0–11.0)	<0.01
30-day readmission	4.4% (4)	14.3% (2)	0.18

[a] Comorbidities include: Pulmonary (Chronic Obstructive Pulmonary Disease, Asthma), CV (Coronary Artery Disease, Cevebrovascular Accident, Myocardial Infarction, Atrial Fibrillation, Congestive Heart Failure), GI (Cirrhosis, Peptic Ulcer Disease, Inflammatory Bowel Disease), Endocrine (Diabetes, Thyroid Disease), Renal (Chronic Renal Failure, Acute Renal Failure), Hematologic (History of Deep Venous Thrombosis or bleeding/clotting disorder), Cancer (Solid organ or hematologic malignancy).

Table 2
Outcomes. *Table gives median (IQR) (N) or % (N).*

	Underwent protocol overall (N = 91)	Underwent protocol, clear in 12 (N = 48)	Underwent protocol, clear in 24 but not 12 (N = 22)	Underwent protocol, not clear in 24 (N = 21)	Straight to OR (N = 14)
Hospital LOS	3 (2–7) (91)	2 (2–3) (48)	4.5 (3–7) (2)	8 (7–19) (21)	8.5 (7–11) (14)
Nights to surgery	3 (2–5) (23)	1 (1-1) (1)	4 (3–6) (4)	2.5 (2–5) (18)	1 (0–1) (13)
Death Rate	0.0% (0/91)	0.0% (0/48)	0.0% (0/22)	0.0% (0/21)	0.0% (0/14)
Complication Rate	12.1% (11/91)	4.2% (2/48)	4.6% (1/22)	38.1% (8/21)	50.0% (7/14)

required bowel resection. Patients needing immediate surgery had a median LOS of 8.5 days and median nights to surgery was 1. Overall complication rate in the straight to OR group was 50.0% (Table 3); 28.6% of patients had infections and 7.1% received transfusions (Table 3).

Three patients did not follow the study protocol. One patient did not follow the protocol because the etiology for the obstructive process was believed to be an abscess necessitating IR drainage. The second had multiple failed attempts to successfully place an NGT. The third, while initially admitted to a surgical service, was transferred to the medicine service. The remaining 91 patients received the WSC protocol. The mean age was 55 and the majority (53%) were men with a mean BMI of 25 (Table 1).

Of the 91 patients who followed the protocol, 77% (n = 70) had passage of contrast to the colon. Contrast passed to the colon between 0 and 12 h in 48 patients and between 12 and 24 h in 22 patients. A majority of these (91%, 64/70), were managed non-operatively. Of the 6 patients who underwent surgery after having contrast pass to colon, 3 required SBR (Table 2). The decision to proceed to surgery despite passage of contrast to the colon, was at the discretion of the Attending Surgeon. Twenty-one patients (23%) had failure of contrast to progress to the colon within 24 h. All but three of these, underwent surgery; 44% (n = 8) had adhesiolysis and 56% (n = 10) required small bowel resection (SBR) (Table 2). Of the patients who underwent SBR, two had small bowel resected due to enterotomy related to extensive adhesiolysis.

In the 48 patients who had contrast to the colon in under 12 h, median LOS was 2 days and the complication rate was 4.2%. Median nights to surgery (in those who underwent surgery) was 1. The 22 patients who had contrast to the colon between 12 and 24 h and had a median LOS of 4.5 days and a complication rate of 4.6%. Median nights to surgery (in those who underwent surgery) was 4 days. In the 21 patients who failed WSC and subsequently underwent surgery, median LOS was 8 days (Table 2). Their complication rate was 38.1%. A majority of those complications can be attributed to infections (23.8%) and need for transfusion (14.3%) (Table 3). There was no mortality in the study cohort.

Table 3
Complication rates by protocol group and complication type. Table gives %(N). Patients can have more than one complication type.

	Underwent protocol overall	Underwent protocol, clear in 12	Underwent protocol, clear in 24 but not 12	Underwent protocol, not clear in 24	Straight to OR
Overall complication rate	12.1% (11/91)	4.2% (2/48)	4.6% (1/22)	38.1% (8/21)	50.0% (7/14)
Infection rate	7.7% (7/91)	4.2% (2/48)	0.0% (0/22)	23.8% (5/21)	28.6% (4/14)
Transfusion rate	3.3% (3/91)	0.0% (0/48)	0.0% (0/22)	14.3% (3/21)	7.1% (1/14)
Other complication rate	5.5% (5/91)	0.0% (0/48)	4.6% (1/22)	19.0% (4/21)	28.6% (4/14)

Discussion

This was a retrospective study of patients with SBO from two large metropolitan institutions that adopted a uniform protocol for management of SBO using WSC. This protocol was modified and adapted from prior published work by Jordan et al..[3] The ability to differentiate those who can be managed non-operatively from those who require adhesiolysis or bowel resection accurately and in a timely manner, is paramount; and adoption of a uniform protocol can aid in doing so without increasing LOS, morbidity, or mortality, as has been well demonstrated in the literature.[3,9—11] Moreover, some investigators have found that WSC administration reduced operative rates and success of conservative treatment.[5,12] We demonstrated a 74% rate of successful non-operative management using our WSC protocol. We found that implementation of a WSC protocol facilitates early recognition of partial from complete obstruction and may decrease hospital length of stay. For those patients who will ultimately require an operation, timely intervention is paramount, as outcomes are highly dependent on early identification of those patients who will require operative intervention, and subsequent timely operation.

Amongst the patients who underwent WSC protocol, 77% demonstrated contrast passage to the colon within 24 h. Of those, 91% underwent NOM, while 9% underwent surgery. Of the 9% who underwent surgery, half required SBR (Table 1). This was intriguing to us; for if the patient successfully demonstrated contrast passage, it should stand to reason that surgical intervention would not be warranted. The fact that these 6 patients underwent surgery underscores the value of physical exam and clinical judgement in addition to imaging findings. Upon chart review, it was found that these patients were taken to the operating room due to excessive abdominal pain and worsened abdominal exam, after passage of contrast. Four of the six patients demonstrated a documented history of multiple (>4) prior abdominal operations.

In patients who underwent WSC protocol, overall LOS was 3 days. This compares to similar decreased LOS observed in previous studies as well, with one study having observed decreased LOS to 3 days following implementation of WSC protocol, as compared to 11 days prior to protocol implementation.[3,5,7] This has tremendous implications in terms of health care utilization and hospital costs. Whereas the average cost for a single day of care on a medical-surgical floor at a hospital in our state is $2,631, the cost of a WSC study-a bottle of gastrograffin ($614), and two abdominal x-rays ($72 each) - is only $758.[13—15]

We observed high complication rates in patients who underwent laparotomy. This was true for all patients that underwent operation regardless of contrast administration. In those that had a WSC challenge and did not clear contrast within 24 h, a significant segment of these complications were secondary to infections and need for transfusions. Neither of these complications can plausibly be attributed to the administration of contrast. Similarly, in patients who underwent emergent laparotomy over half of what was classified as a complication in this cohort, was having undergone transfusion (23.8%) (Table 3). This cohort of patients (those who underwent immediate laparotomy) overall were older (58.0 vs 55.0), had more comorbidities at baseline (1 vs 3; p=<0.01), and had a longer overall LOS (3d vs 9d; p < 0.01) (Table 2). The risk of postoperative complications is strongly predicted by the presence of preoperative comorbidities[14—16]; there is evidence that the presence of 3 or more comorbidities is the strongest preoperative risk factor in some populations.[16] While we observed high complication rates in all operative groups, the complication rate in the group who underwent emergency surgery was still higher. This suggests that waiting to operate until after a WSC challenge in a patient who meets appropriate criteria is safe and will not result in a higher rate of complication than operating urgently.

The administration of a WSC agent serves both diagnostic and therapeutic purpose.[2,3,5,6,17] Its high osmolality (approximately 6 times that of extracellular fluid), increases the pressure gradient across the obstruction, promotes an intraluminal fluid shift, decreases bowel edema, and increases bowel motility.[9,11] Its therapeutic effect is profound, with one group reporting a resolution of obstruction in over 80% within 6.5 h of contrast administration.[5]

Our goal was to review LOS, morbidity, and mortality in our two institutions after universal institution of a protocolized approach to the management of SBO. Our successful use of a WSC protocol to differentiate in a timely manner, those patients whose SBO requires urgent surgical intervention from those who can be managed non operatively, is consistent with previously reported success rates with WSC administration in patients with SBO.[3,5,9] Delay in appropriate and expeditious operative management of patients with small bowel obstruction may cause a profound increase of morbidity and mortality.[5] Conversely, the ability to safely identify patients who are candidates for NOM prevents unnecessary surgery, decreases postoperative complications and subsequent risk of development of future SBO.[18]

There are several limitations of our study. First, our analysis was performed as a retrospective review. As such, there is potential variability in terms of recording of clinical findings, patient management, and subsequent data collection. Second, as a retrospective review, we were able to report 74% successful non operative management, however, there is no way to know absent completion of a randomized controlled trial whether this would have occurred with NGT decompression alone. Third, as a retrospective review, while for some patients a comprehensive list of prior abdominal surgeries was able to be identified by chart review, for others, this was not found, and instead there were statements such as "multiple prior surgeries," or "a few prior laparotomies," limiting our ability to quantify the number of prior abdominal operations for all patients. Fourth, "time to surgery" was defined as "nights to surgery" and hours to surgery were not quantified. Finally, this retrospective study only reviewed admissions during a one year time frame. No data as to long term follow-up or recurrence are known in this cohort.

In summary, implementation of a water-soluble contrast protocol facilitates early recognition of partial from complete small bowel obstruction and may decrease hospital length of stay, in turn decreasing healthcare costs for this common disease process.

Conflicts of interest

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