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Small Bowel

Timing of Gastrografin administration in the management of adhesive small bowel obstruction (ASBO): Does it matter?

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ABSTRACT

Background: Gastrografin challenge is increasingly used as a diagnostic tool to predict patients who may benefit from nonoperative management in adhesive small bowel obstruction. This study explores the optimal timing of Gastrografin in the management of adhesive small bowel obstruction by comparing early versus late Gastrografin challenge.

Methods: A retrospective chart review from January 2016 to January 2018 identified patients with adhesive small bowel obstruction who underwent Gastrografin challenge. A receiver operating characteristic curve, to predict a duration of stay less than 5 days, calculated a 12-hour limit which separated early and late groups. Nonoperative and operative patients were compared separately. Our primary outcome was duration of stay. Secondary outcomes included operative requirement, time to the operating room, complication rate, and 1-year mortality. In a separate analysis, multivariable logistic regression identified independent risk factors for 1-year mortality.

Results: One hundred thirty-four patients were identified (58 early, 76 late). In nonoperative patients, the early group had a shorter duration of stay (3.2 days vs 5.4 days), fewer complications, and a lower complication and 1-year mortality rate ($P < .05$). In operative patients, the early group had a shorter preoperative duration of stay (1.8 days vs 3.9 days) ($P < .05$). On multivariable regression, congestive heart failure, any postoperative complication, and operative requirement were the best predictors of 1-year mortality ($R2 = 0.321$; $P < .05$).

Conclusion: Gastrografin administration within 12 hours of adhesive small bowel obstruction diagnosis had favorable outcomes in terms of duration of stay, complications, and mortality in nonoperative patients. Moreover, in operative patients, preoperative duration of stay was shortened. Our findings suggest protocolizing early Gastrografin challenge may be an important principle in adhesive small bowel obstruction management.

Introduction

The decision to operate on a patient with adhesive small bowel obstruction (ASBO) has long presented a management dilemma. The old paradigm of early operative intervention introduced the adage, "never let the sun set on a bowel obstruction."[1] There is now strong evidence that an initial trial of nonoperative management is safe in properly selected patients.[2–4] Oral, water-soluble contrast agents (WSCA), such as diatrizoate meglumine-diatrizoate sodium (Gastrografin), have proved useful in selecting those who will fail nonoperative management.

The presence of Gastrografin in the colon on serial plain-film radiography, known as a "Gastrografin challenge," may predict resolution of a partial bowel obstruction.[5] The prognostic function of Gastrografin often obviates the need for surgery earlier in the hospital course, which can reduce duration of stay[5,6] and curb health care costs.[7] WSCA may also have therapeutic value in accelerating the resolution of ASBO[6,8] and reducing the need for operative intervention,[9,10] although evidence in this respect remains equivocal.[11–13] The therapeutic mechanism of the action of Gastrografin is thought to be based on its properties as an osmotic compound and a wetting agent, shifting water into the bowel lumen and facilitating bowel motility.[14]

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Considering the diagnostic and possible therapeutic utility of Gastrografin, we hypothesized that early Gastrografin administration may provide a clinical benefit in patients with ASBO. As a diagnostic tool, early contrast use may accelerate clinical decision-making by triaging operative and nonoperative patients earlier in the hospital course. As a therapeutic modality, timely Gastrografin administration may be important in relieving interstitial edema within a critical window before a complete obstruction or strangulation forms.

The purpose of our study was to assess the optimal timing of WSCA administration in the management of ASBO by comparing early (≤12 hours) and late (>12 hours) use. Our primary outcome was mean duration of stay. Secondary outcomes included operative requirement, mean time to the operating room (OR), mean number of complications, complication rate, 1-year recurrence rate, and 1-year mortality rate. Additionally, bivariate analysis and multivariable logistic regression were used to assess if the timing of Gastrografin administration or any other factors were predictive of 1-year mortality in our cohort.

Methods

This is a retrospective chart review from a database of patients who were diagnosed with ASBO by computed tomography (CT) scan from January 2016 to January 2018 and underwent Gastrografin challenge. Data was collected from 2 separate hospitals within a single health care system. Internal review board approval was obtained.

Only patients who presented with signs and symptoms of abdominal pain and received a diagnostic CT scan were included. Our institutional policy is to avoid contrast use on initial CT scan in patients who might have an obstruction. All patients were subsequently treated with nasogastric decompression and received a 60 to 90 cc Gastrografin challenge as part of their diagnostic workup. Patients who presented with small bowel obstruction owing to a reason other than adhesive disease, such as a mass, volvulus, inflammatory bowel disease, or hernia, were not included. Patients with signs of strangulation or perforation, corresponding to the American Association for the Surgery of Trauma grades IV and V obstructions, were not included.[15,16] Patients who had been operated on within 6 weeks of presentation or with no abdominal surgical history were not included.

A receiver operating characteristic (ROC) curve was created to determine the optimal threshold of time to Gastrografin administration. Details of this are presented in the statistical methods section. Based on the ROC curve, a 12-hour cutoff was selected. Subsequently, patients were classified into early (≤12 hours) or late (>12 hours) groups of Gastrografin administration after diagnosis by CT. Time to Gastrografin administration and time to OR were calculated using the number of hours from the performance of an initial diagnostic CT scan in the emergency room. Baseline characteristic including age, sex, body mass index (BMI), comorbidities, and surgical history were compared between the 2 groups. Our primary outcome was duration of stay. Secondary outcomes included operative requirement, mean time to the OR, complications, complication rate, 1-year recurrence rate, and 1-year mortality rate. Operative patients and nonoperative patients were compared independently.

We performed a separate analysis to assess 1-year survival in our patient population. Patients were classified into ≥1-year survivor and nonsurvivor groups. The timing of Gastrografin administration was compared between the 2 groups, along with other factors including comorbidities, surgical history, complications, and operative requirement. All variables that were significant on bivariate analysis were included in a multivariate stepwise logistic regression to determine which variables were independent risk factors for 1-year mortality.

Statistical methods

A ROC curve was created to determine the optimal threshold of time to Gastrografin administration. The curve demonstrated the sensitivity and specificity of the timing of Gastrografin administration across the spectrum of test values, to predict a duration of stay ≤5 days. The resulting cutoff value, 12 hours, had optimal sensitivity and specificity at 80% and 57%, respectively, in predicting a duration of stay ≤5 days (Fig 1). A duration of stay of 5 days was chosen because it reflected the average duration of stay in ASBO patients.[1] This value represented best practices for ASBO management. The 12-hour cutoff was calculated before any statistical comparisons were performed.

T testing and χ^2 were used to compare continuous and categorical variables between each study group. Statistical analyses were 2-sided and $P < .05$ was considered statistically significant. In our survival analysis, variables with $P < .05$ were included in a multivariable logistic regression for the outcome measure of 1-year mortality. All statistical analysis was conducted using SPSS, version 22 (IBM Corporation, Armonk, NY).

Results

For the 134 patients who met inclusion criteria, the mean age was 66.7 years (standard deviation 17.68). Mean time to Gastrografin administration was 28.0 hours (standard deviation 29.3). Table I shows patient characteristics and outcomes for the entire cohort. Of all patients, 20.1% required an operative intervention. One-year mortality was 8.2%.

Table II shows the instances of in-hospital complications for the entire cohort separated by subgroup. In total, 6 patients died during hospitalization. Acute kidney injury was the most common in-hospital complication, affecting 11 patients. There was 1 aspiration event, but this was not related to Gastrografin use. No in-hospital complications were directly related to Gastrografin administration.

Table III compares early and late Gastrografin administration in nonoperative patients. Between the early and late groups, there was no statistically significant difference in baseline demographics including age, sex, BMI, and surgical history. The late group did have a higher incidence of arrhythmia than the early group. Otherwise, there was no significant difference in any baseline comorbidities. In terms of outcomes, the early group had a shorter duration of stay (3.2 days vs 5.4 days), fewer mean number of complications (0.08 vs 0.43), a lower complication rate (8.2% vs 27.6%), and a lower 1-year mortality rate (0.0% vs 10.3%) ($P < .05$).

Table IV compares early and late Gastrografin administration in operative patients. Between the early and late groups, there was no statistically significant difference in baseline demographics including age, sex, BMI, comorbidities, and surgical history. In terms of outcomes, the early group had a shorter preoperative duration of stay (1.8 days vs 3.9 days) and shorter mean time to OR (43.7 hours vs 94.6 hours). Other outcomes including overall duration of stay, postoperative duration of stay, complications, 1-year recurrence, and 1-year mortality were not significantly different between the groups.

Table V shows our comparison of ≥1-year survivors to nonsurvivors. Compared with survivors, nonsurvivors had a higher mean age, longer mean time to Gastrografin administration, higher incidence of congestive heart failure (CHF), higher mean number of

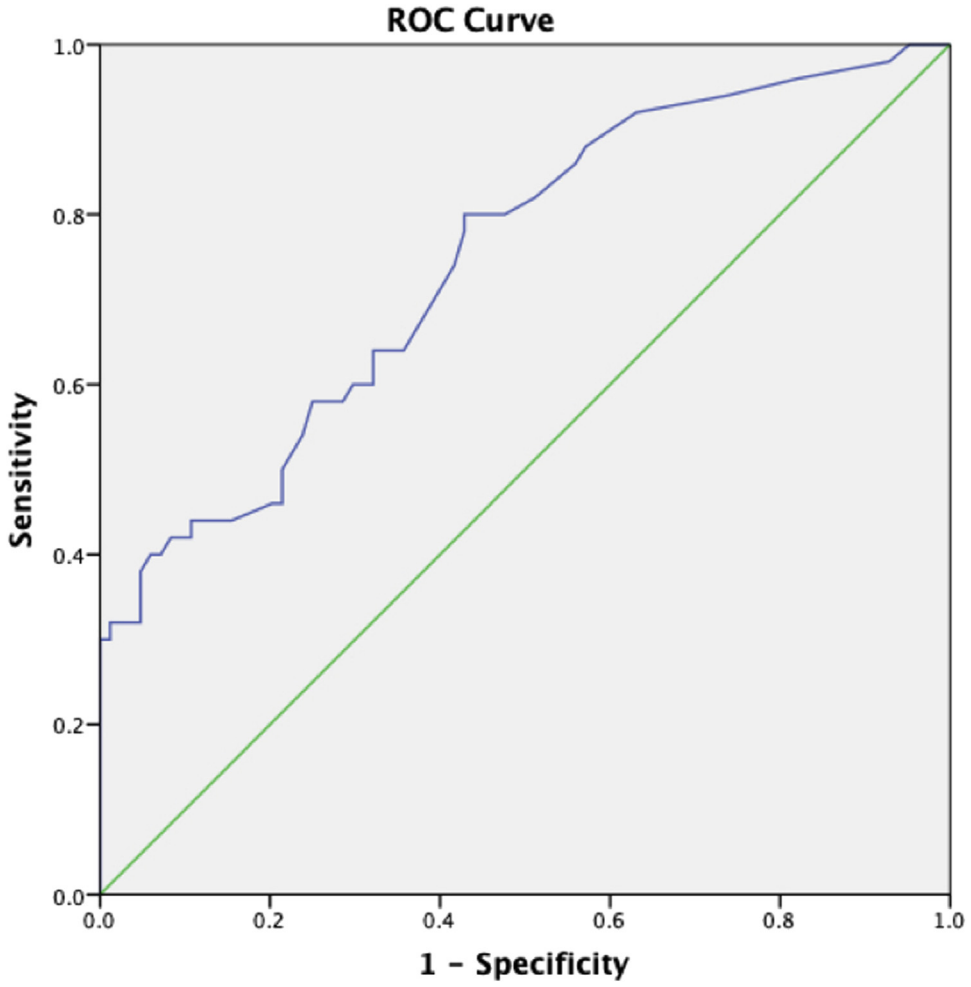

Fig 1. Receiver operating characteristic curve. The blue line charts the sensitivity (y-axis) and 1-specificity (x-axis) at each test value of time to Gastrografin administration as a predictor of duration of stay ≤5 days. The green line corresponds to random chance. Based on the analysis, a 12-hour cutoff predicted a duration of stay ≤5 days with optimal sensitivity and specificity, at 80% and 57%, respectively. The area under the curve was .746. (Color version of figure is available online.)

Table I
Cohort characteristics and outcomes

Patient characteristics	Results ($N = 134$)
Age, mean (SD), y	66.7 (17.7)
No (%) Female	79 (59.0)
BMI, mean (SD)	28.3 (6.4)
No (%) with >1 previous abdominal surgery	76 (56.7)
No (%) with ASBO episode in the last 5 y	40 (29.9)
Time to Gastrografin administration, mean (SD), h	28.0 (29.3)
Cohort outcomes	
No (%) OR required	27 (20.1)
No (%) received Gastrografin within 12 h of presentation	58 (43.3)
Time to OR, mean (SD), h	77.6 (49.6)
No (%) with any complication	27 (20.1)
Number of complications, mean (SD)	.31 (.76)
Duration of stay, mean (SD), d	5.8 (4.2)
No (%) 1-y mortality rate	11 (8.2)

ASBO, adhesive small bowel obstruction; *BMI,* body mass index; *OR,* operating room; *SD,* standard deviation.

complications and complication rate, higher OR requirement, and longer duration of stay ($P < .05$). On multivariable logistic regression, after controlling for other factors, CHF, any postoperative complication, and operative requirement were the best independent predictors of 1-year mortality ($R2 = 0.321$; $P < .05$) (Table VI).

Discussion

ASBO is a common cause of emergency department visits and inpatient hospitalizations in patients with previous abdominal surgery.[17,18] The management of ASBO is associated with significant morbidity and cost to the health care system.[18,19] This may be largely explained by the high recurrence rate of the disease and the frequent need for urgent operative interventions.[20,21] A 2016 study found that lysis of peritoneal adhesions was the fifth most burdensome procedure performed in the United States based on mortality, complications, and health care cost.[22]

The decision to operate on patients with ASBO has long presented a diagnostic dilemma. In their landmark study in 2013, Schraufnagel et al showed that 4 or more preoperative days was associated with prolonged duration of stay and increased mortality, reinforcing an overall trend favoring early operative intervention.[1] This is contrasted by level 1 evidence and societal guidelines validating the safety of initial nonoperative management in patients without generalized peritonitis or clinical deterioration.[2] Over the last decade, a more nuanced approach has been advocated, using the guidance of WSCA to predict who will fail a nonoperative trial.[23] Echoing this sentiment, recent guidelines recommended water-soluble contrast imaging, using a Gastrografin challenge, as part of the standard management of ASBO.[4] However, the optimal

Table II
Instances of in-hospital complications by subgroup

Complications	Nonoperative		Operative		Total instances (complication rate)
	Early	Late	Early	Late	
Aspiration event	0	1	0	0	1 (.75%)
Arterial thrombus	0	0	0	1	1 (.75%)
DVT	0	1	0	0	1 (.75%)
Malnutrition	0	0	0	1	1 (.75%)
PE	0	1	0	0	1 (.75%)
UTI	0	1	0	0	1 (.75%)
Wound infection	0	0	1	0	1 (.75%)
Shock/sepsis	0	3	0	0	3 (2.2%)
ARF	1	3	0	2	6 (4.5%)
Death	0	2	1	3	6 (4.5%)
AF	1	7	0	1	9 (6.7%)
AKI	2	6	1	2	11 (8.2%)

AF, atrial fibrillation; *AKI,* acute kidney injury; *ARF,* acute respiratory failure; *DVT,* deep venous thrombosis; *PE,* pulmonary embolism; *UTI,* urinary tract infection.

Table III
Nonoperative patients—Comparing early and late groups

Nonoperative patients ($n = 107$)	Early group ($n = 49$)	Late group ($n = 58$)	*P* value
Baseline info			
No (%) female	26 (53.1)	34 (58.6)	.351
BMI, mean (SD)	28.4 (6.5)	28.7 (6.5)	.769
Age, mean (SD), y	64.0 (18.5)	70.1 (17.5)	.082
No (%) with >1 previous abdominal surgery	29 (59.2)	35 (60.3)	.530
No (%) with SBO episode in the last 5 y	18 (36.7)	20 (34.5)	.483
Time to Gastrografin administration, mean (SD), h	7.1 (2.7)	44.3 (31.1)	.000*
Past surgeries			
No (%) cholecystectomy	10 (20.4)	13 (22.4)	.495
No (%) appendectomy	11 (22.4)	9 (15.5)	.252
No (%) colorectal	7 (14.3)	11 (19.0)	.352
No (%) gastroduodenal	1 (2.0)	5 (8.6)	.147
No (%) vascular surgery (abdominal)	2 (4.1)	2 (3.4)	.625
No (%) gynecological	20 (40.8)	21 (36.2)	.386
No (%) small bowel	26 (53.1)	25 (43.1)	.202
No (%) other surgery	5 (10.2)	7 (12.1)	.504
Mean total previous surgical categories,† mean (SD)	1.7 (.72)	1.6 (.77)	.630
Comorbidities			
No (%) diabetes	23 (46.9)	23 (39.7)	.287
No (%) hypertension	33 (67.3)	40 (69.0)	.511
No (%) cirrhosis	3 (6.1)	6 (10.3)	.336
No (%) current or former smoker	15 (30.6)	19 (32.8)	.489
No (%) COPD	4 (8.2)	8 (13.8)	.273
No (%) CAD	8 (16.3)	18 (31.0)	.061
No (%) CHF	7 (14.3)	12 (20.7)	.272
No (%) arrhythmia	3 (6.1)	13 (22.4)	.017*
No (%) CKD	6 (12.2)	8 (13.8)	.523
Outcomes			
Duration of stay, mean (SD), d	3.2 (1.6)	5.4 (2.8)	.000*
Number of complications, mean (SD)	.08 (.28)	.43 (.90)	.007*
No (%) complication rate	4 (8.2)	16 (27.6)	.009*
No (%) 1-y recurrence rate	9 (18.4)	14 (24.1)	.314
No (%) 1-y mortality rate	0 (0)	6 (10.3)	.022*

BMI, body mass index; *CAD,* coronary artery disease; *COPD,* chronic obstructive pulmonary disease; *CHF,* congestive heart failure; *CKD,* chronic kidney disease; *SBO,* small bowel obstruction; *SD,* standard deviation.
* Statistically significant ($P < .05$).
† Mean number of surgeries from each of the categories listed.

timing of Gastrografin administration within this approach remains unclear.

Eight randomized controlled trials from 1996 to 2017 studying the diagnostic and therapeutic role of WSCA in ASBO presented no consensus on the duration of nonoperative management.[7–13,24] Six of the trials administered Gastrografin after a nonspecified period of nasogastric decompression, presumably relying on provider preference. Di Saverio et al described a Gastrografin meal given immediately after diagnosis of ASBO.[9] The most recent trial by Scotte et al protocolized 100 cc of Gastrografin given after 2 hours of nasogastric tube decompression.[12]

We propose a 12-hour cutoff as an optimal time frame for administration of Gastrografin. The cutoff point was determined before our statistical analysis based on retrospective data, hence it presents limitations. Nonetheless, we favor using this cutoff because it is data driven. Moreover, we think a 12-hour cutoff fits well clinically in the general paradigm of modern shift-based acute care surgery.

This is the first study to show a clinical benefit to early Gastrografin challenge, within 12 hours of diagnostic CT scan, in the management of ASBO. In terms of our primary outcome, early Gastrografin administration shortened duration of stay by about 2

Table IV
Operative patients—Comparing early and late groups

Operative patients ($n = 27$)	Early group ($n = 9$)	Late group ($n = 18$)	P value
Baseline info			
No (%) female	6 (66.7)	13 (72.2)	.550
BMI, mean (SD)	27.3 (7.0)	27.1 (5.5)	.929
Age, mean (SD), y	68.3 (12.8)	62.2 (17.0)	.352
No (%) with >1 previous abdominal surgery	3 (33.3)	9 (50.0)	.343
No (%) with SBO episode in the last 5 y	0 (0.0)	2 (11.1)	.436
Time to Gastrografin administration, mean (SD), h	7.7 (2.3)	42.9 (28.7)	.000*
Past surgeries			
No (%) cholecystectomy	0 (0.0)	2 (11.1)	.436
No (%) appendectomy	0 (0.0)	3 (16.7)	.279
No (%) colorectal	2 (22.2)	5 (27.8)	.571
No (%) gastroduodenal	1 (11.1)	1 (5.6)	.564
No (%) vascular surgery (abdominal)	0 (0.0)	0 (0.0)	1.0
No (%) gynecological	6 (66.7)	8 (44.4)	.249
No (%) small bowel	1 (11.1)	7 (38.9)	.149
No (%) other surgery	1 (11.1)	2 (11.1)	.721
Mean total previous surgical categories,† mean (SD)	1.2 (.44)	1.6 (.71)	.146
Comorbidities			
No (%) diabetes	3 (33.3)	3 (16.7)	.305
No (%) hypertension	6 (66.7)	13 (72.2)	.550
No (%) cirrhosis	0 (0.0)	1 (5.6)	.667
No (%) current or former smoker	1 (11.1)	9 (50.0)	.057
No (%) COPD	1 (11.1)	2 (11.1)	.721
No (%) CAD	1 (11.1)	0 (0.0)	.333
No (%) CHF	2 (22.2)	2 (11.1)	.407
No (%) arrhythmia	3 (33.3)	1 (5.6)	.093
No (%) CKD	1 (11.1)	0 (0.0)	.333
Outcomes			
Duration of stay, mean (SD), d	9.6 (2.5)	12.5 (5.2)	.122
Preoperative duration of stay, mean (SD), d	1.8 (.97)	3.9 (2.1)	.007*
Postoperative duration of stay, mean (SD), d	7.8 (2.0)	8.6 (4.6)	.544
Time to OR, mean (SD), h	43.7 (24.1)	94.6 (50.7)	.009*
Number of complications, mean (SD)	.33 (.71)	.56 (1.04)	.571
No (%) complication rate	2 (22.2)	5 (27.8)	.571
No (%) 1-y recurrence rate	1 (11.1)	2 (11.1)	.721
No (%) 1-y mortality rate	2 (22.2)	3 (16.7)	.553

BMI, body mass index; *CAD,* coronary artery disease; *COPD,* chronic obstructive pulmonary disease; *CHF,* congestive heart failure; *CKD,* chronic kidney disease; *OR,* operating room; *SBO,* small bowel obstruction; *SD,* standard deviation.
* Statistically significant ($P < .05$).
† Mean number of surgeries from each of the categories listed.

Table V
Comparing ≥1-y survivors and nonsurvivors

	≥1-y survivors ($n = 123$)	Nonsurvivors ($n = 11$)	P value
Baseline info			
No (%) female	72 (58.5)	7 (63.6)	.503
BMI, mean (SD)	28.1 (6.05)	29.9 (9.66)	.377
Age, mean (SD), y	65.8 (18.0)	77.2 (9.68)	.003*
No (%) with >1 previous abdominal surgery	71 (57.7)	5 (45.5)	.317
No (%) with SBO episode in the last 5 y	38 (30.9)	2 (18.2)	.307
Time to Gastrografin administration, mean (SD), h	26.5 (28.3)	45.4 (35.7)	.040*
Comorbidities			
No (%) diabetes	47 (38.2)	5 (45.5)	.433
No (%) hypertension	84 (68.3)	8 (72.7)	.529
No (%) cirrhosis	8 (6.50)	2 (18.2)	.192
No (%) current or former smoker	41 (33.3)	3 (27.3)	.484
No (%) COPD	12 (9.8)	3 (27.3)	.108
No (%) CAD	25 (20.3)	2 (18.2)	.612
No (%) CHF	17 (13.8)	6 (54.6)	.004*
No (%) arrhythmia	19 (15.5)	1 (9.09)	.488
No (%) CKD	14 (11.4)	1 (9.09)	.645
Outcomes			
Time to OR, mean (SD), h	80.2 (52.5)	56.0 (33.1)	.386
Number of complications, mean (SD)	.200 (.490)	1.64 (1.63)	.015*
No (%) with any complication	20 (16.2)	7 (63.6)	.001*
No (%) with OR required	22 (17.9)	5 (45.5)	.044*
Duration of stay, mean (SD), d	5.48 (3.89)	9.36 (6.17)	.003*

BMI, body mass index; *CAD,* coronary artery disease; *COPD,* chronic obstructive pulmonary disease; *CHF,* congestive heart failure; *CKD,* chronic kidney disease; *OR,* operating room; *SBO,* small bowel obstruction; *SD,* standard deviation.
* Statistically significant ($P < .05$).

Table VI
Regression analysis—Independent predictors for 1-y survival, R2 = .321; $P < .05$

Variable	Significance	Odds ratio	95% CI
CHF	.016	6.14	1.40–26.94
Any complication	.013	6.10	1.46–25.42
Operative requirement	.055	4.34	.97–19.52

CHF, congestive heart failure; *CI*, confidence interval.

days in nonoperative patients. Although it did not significantly reduce overall duration of stay in operative patients, it did significantly shorten preoperative duration of stay and time to OR.

In our comparison of early and late Gastrografin use in nonoperative patients, duration of stay, number of complications, complication rate, and 1-year mortality were significantly lower in the early group. We attribute these gains to limiting the morbidity of prolonged nonoperative management in patients who received Gastrografin early. Several studies have demonstrated faster resolution of symptoms, return of first stool, and initiation of oral feeds with Gastrografin use compared with standard nonoperative management.[6,24] We suggest that early Gastrografin use would potentiate this process. From a diagnostic standpoint, nonoperative patients who received Gastrografin early were triaged toward conservative management sooner, which likely accelerated the resumption of enteral nutrition, minimized the morbidity of prolonged nasogastric decompression, and resulted in sooner discharge.

The overall complication rate in nonoperative patients who received Gastrografin late was quite high (27.6%) compared with the early group (8.2%). It is well established that prolonged gastric drainage is associated with physiologic derangements—most notably dehydration, electrolyte abnormalities, renal dysfunction, and metabolic alkalosis.[4,25,26] In our study population, the most common complication was acute kidney injury (AKI) (11 cases). Over half of the AKI cases were represented in nonoperative patients who received Gastrografin late (6 cases). We suspect the disproportionate incidence of AKI in this group likely reflects the known association of prolonged nasogastric tube decompression and dehydration in the setting of extended hospital stay. Other complications were also represented disproportionately in nonoperative patients who received Gastrografin late, including atrial fibrillation (7 cases), respiratory failure (3 cases), and sepsis (3 cases). Similarly, these complications may be a reflection of the deleterious effects of prolonged hospitalization.

We hypothesize that early Gastrografin use did not translate to similar gains in morbidity and mortality in operative patients largely owing to an "equalizing" effect of surgery. Specifically, outcomes in operative patients were more a result of complications inherent to surgery and the postoperative period, which were identical between the early and late groups, rather than the morbidity of a prolonged preoperative period. It should be noted that compared with nonoperative patients, the overall complication rate and mortality rate was relatively high. In effect, within the backdrop of surgery-specific complications, the influence of early Gastrografin use in the preoperative window was insignificant.

Additionally, it is possible that the preoperative delay in the late group was not significant enough to produce a clinical change. Although the preoperative duration of stay between the early and late operative groups were significantly different (early 1.8 days, late 3.9 days), operative patients who received Gastrografin late were still operated on in a timely fashion—on average within 4 days of presentation. Multiple studies have shown that extending preoperative duration of stay to 3 to 4 days does not increase overall morbidity and mortality in ASBO patients. Keenan et al, in a review of 9,000 ASBO patients, only found a significant increase in 30-day morbidity and duration of stay after preoperative day 3 and 4, respectively.[27] Similarly, Schraufnagel et al only demonstrated a benefit in mortality and duration of stay if preoperative duration of stay was 4 or more days.[1] Assuming the preoperative delay was not robust enough to affect a difference, it is expected the outcomes between early and late groups would be similar in operative patients.

In addition to improving diagnostic efficiency, early Gastrografin challenge may also confer therapeutic benefits. The pathophysiology of ASBO is a progressive process stemming from a buildup of bowel wall edema in the setting of a mechanical obstruction. Gastrografin contains an ionic compound with considerable osmolarity as well as a wetting agent. The increased osmolarity promotes an intralumenal fluid shift along the obstructive site, while the wetting agent facilitates passage of stool through a narrow lumen.[14] Considering the pathophysiology of ASBO, there may be a critical window after which the degree of interstitial edema cannot be overcome by the osmolar gap created by WSCA. By giving Gastrografin early, within 12 hours in our cohort, we may have optimized this therapeutic window. We hypothesize that nonoperative patients most likely have lower-grade obstructions that are amenable to being reversed or accelerated toward resolution and may have uniquely benefited from a therapeutic standpoint.

Despite the proposed benefits of early Gastrografin use, practitioners may remain hesitant about implementing an early contrast protocol, owing to concern for aspiration, especially in patients with many comorbidities. Notably, of the 148 patients who were reviewed, none of the complications were directly related to Gastrografin administration. In reviewing the literature, complications specific to WSCA, such as aspiration or anaphylaxis, are extremely uncommon.[28] Nonetheless, we anticipate that in clinical practice there may be a selection bias toward avoiding early Gastrografin use in elderly or sick patients. As far as our own analysis, the only significantly different baseline factor between the early and late groups was a higher incidence of arrhythmia in nonoperative patients receiving Gastrografin late. We do not think this association substantive enough to represent a significant selection bias. All other baseline factors, including demographics, BMI, smoking history, previous SBO episodes, surgical history, and comorbidities, were not statistically different between our early and late study groups. Overall, we believe the benefit of early Gastrografin usage outweighs the minor risk of aspiration and should not be a reason to avoid early contrast use, even in those patients with many comorbidities.

In our regression analysis, CHF, having any complication, and operative requirement, considered simultaneously, were the best independent predictors of 1-year mortally. Multiple risk assessment tools have validated CHF as an independent risk factor for complications and mortality before noncardiac surgery.[29,30] In their regression analysis, Schraefnagel et al reported CHF as an independent predictor of death as well.[1] As noted previously, operative requirement in ASBO patients has been associated with mortality.[31,32] Similar findings have been found in terms of postoperative complications and mortality.[33] Although mean time to Gastrografin administration was lower in the survivor group, this did not withstand multivariate regression. It remains unclear whether early administration WSCA affords any added benefit in terms of mortality. We suspect if there is any mortality benefit to early Gastrografin use, it is specific to decreasing prolonged conservative management, especially in nonoperative patients.

There were several limitations to our study. There are inherent biases with information recall associated with retrospective studies. We did not compare our findings to a control group of patients who did not receive WSCA. Moreover, we did not know the

duration of symptoms in patients in our cohort before hospitalization. Although baseline characteristics including surgical history and medical comorbidities were similar between groups, it is unknown if the duration of symptoms before hospitalization effected our study design and results.

In conclusion, this is the first study to find a benefit to early Gastrografin challenge in the management of ASBO. Our analysis supports the notion of selective nonoperative management, with an emphasis on timely Gastrografin use. We propose a maximum 12-hour window of nonoperative nasogastric decompression before a Gastrografin challenge. Protocolizing such a measure to a comprehensive bowel obstruction algorithm will likely decrease duration of stay and time to OR, which could have overarching effects on health care cost. Early Gastrografin may also improve the morbidity and mortality associated with prolonged nonoperative management. In the future, further prospective studies are needed to explore the benefits of early Gastrografin use.

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Conflict of interest/Disclosure

There are no conflicts of interest associated with this manuscript and its authors.

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