Small bowel obstruction: A practical step-by-step evidence-based approach to evaluation, decision making, and management

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Small bowel obstruction (SBO) remains a significant burden to the health care system, to providers, and most importantly, to patients. In 1994, SBO accounted for more than 300,000 hospitalizations and more than 846,000 days of inpatient care, totaling $1.3 billion in cost to the US health care system.[1] For providers, it represents a challenging entity: if its diagnosis has become relatively straightforward with the use of computed tomography (CT) scans, the decision-making process and operative management remain difficult. For patients, the mainstay of treatment remains the dreaded and uncomfortable nasogastric tube (NGT). The physical discomfort caused by the NGT is heightened by the psychological burden associated with the uncertainty regarding its eventual withdrawal.

However, progress has been made in the past years regarding the different aspects of SBO management, including the use of water-soluble contrast (Gastrografin, Bracco Diagnostics, Inc., Monroe Township, NJ, or MD-Gastroview, Mallinckrodt, Inc., St. Louis, MO) studies as a tool in the decision-making process and the use of the laparoscopic approach for surgical management. These strategies have significant advantages and could decrease provider uncertainty, patient discomfort, length of stay, and overall costs. Yet, they often have not seen the widespread implementation they deserve. The aim of the current review was therefore to provide an up-to-date and practical summary of the optimal evaluation and management of SBO from initial evaluation to operative technique, relying on the most recent available data and our experience with the methods described herein.

EVALUATION

Primary Evaluation

The goal of the initial evaluation and assessment of the SBO patient is to exclude the presence of bowel ischemia and ensure adequate resuscitation. The presence of SBO is often associated with intravascular hypovolemia secondary to third spacing and dehydration from repeated vomiting. The initial evaluation should therefore focus on basic resuscitation: assessing vitals, obtaining adequate intravenous (IV) access, and evaluating the necessity of more invasive monitoring (Foley catheter, central line, arterial line). In most situations, IV fluids will be required.

In parallel, the initial clinical evaluation will assess signs of sepsis, peritoneal signs, or other metrics, which would raise the suspicion of mesenteric ischemia such as a discrepancy between significant abdominal pain and a paucity of clinical findings, increased lactate levels, and of course, any sign of sepsis or presepsis such as tachycardia, hypotension, and so on. History and physical examination have a cardinal role to play. Obviously, duration and severity of symptoms (absence of bowel movements and gas) are fundamental. Surgical history should inquire about previous procedures and specifically assess for operations with a potential for internal hernias such as gastric bypass or bowel resections. The presence of previous episodes of SBO should be documented, as well as their management and outcome. A thorough physical evaluation will assess the presence of peritoneal signs and actively look for the presence of an incarcerated abdominal wall or inguinal hernia. In the presence of sepsis, hypotension, and/or peritoneal signs, immediate surgical exploration should be considered.

Secondary Evaluation

In the absence of any of these "alarming" symptoms in a stable patient, CT scan adds high value.[2–5] Since clinical signs of ischemia are sometimes lacking, CT can help avoid inadvertent nonoperative management of a patient with bowel ischemia or strangulation. CT has a greater than 90% sensitivity and specificity for identifying bowel ischemia and, thus, has become the preferred imaging modality.[2] It is also useful for diagnosing nonadhesional causes of SBO and identifying the level and location of obstruction.[2] The ideal CT should be obtained with IV contrast to identify vascular patency and evaluate bowel wall enhancement.[3] Decreased bowel wall enhancement has been shown to identify ischemia with greater than 95% sensitivity and a 99% negative predictive value. The combined finding of two of the following: mural thickening, mesenteric fluid, congestion of small mesenteric veins, and ascites also has the same sensitivity and negative predictive value.[6] Add leukocytosis of more than 12,000 or guarding on physical examination to the CT finding of decreased wall enhancement, and specificity approaches 100% for ischemia.[4] Thus, if the CT suggests bowel ischemia, urgent exploration should be undertaken. Other radiographic signs concerning for etiologies, which are a contraindication to nonoperative management, should be taken into consideration before deciding in favor of nonoperative management: these include suggestion of closed loop obstruction, solid tissue mass, and importantly "mesenteric swirl" in the setting of a potential internal hernia. A common example is patients with a history of Roux-en-Y gastric bypass. In these patients, a very high index of suspicion should be kept for the presence of an internal hernia. Therefore, in the presence of pain and radiologic signs of an internal hernia, these patients should urgently undergo surgical exploration.

CONSERVATIVE MANAGEMENT

Traditional Nonoperative Management

Based on current best practice guidelines,[2,5] patients who lack the previously mentioned concerning imaging findings are appropriate candidates for a trial of nonoperative management. Studies have shown that 76% to 82% of patients with SBO will resolve without surgery.[7,8] Based on 2009 Nationwide Inpatient Sample data, patients successfully treated nonoperatively are hospitalized an average of 4 days.[8] Even patients with high-grade SBO diagnosed by CT can be safely managed nonoperatively.[9]

The traditional nonoperative management entails insertion of an NGT, pain control, serial physical examination, IV fluid replacement, and correction of electrolyte imbalances. During this period, the clinician watches for signs of SBO resolution, such as decreased NGT output, lessening of pain, passage of flatus or bowel movement, and/or improvement in abdominal distention. The clinician also watches for signs of clinical deterioration such as fever, tachycardia, increased abdominal pain/tenderness, and/or worsening abdominal distention. In clinical practice, it is difficult to determine when the patient's condition is improving or worsening, since many of the changes are subtle or occur gradually. The frequent dilemma of nonoperative management is determining when to change the plan or alter the course of treatment. For example, how much improvement in
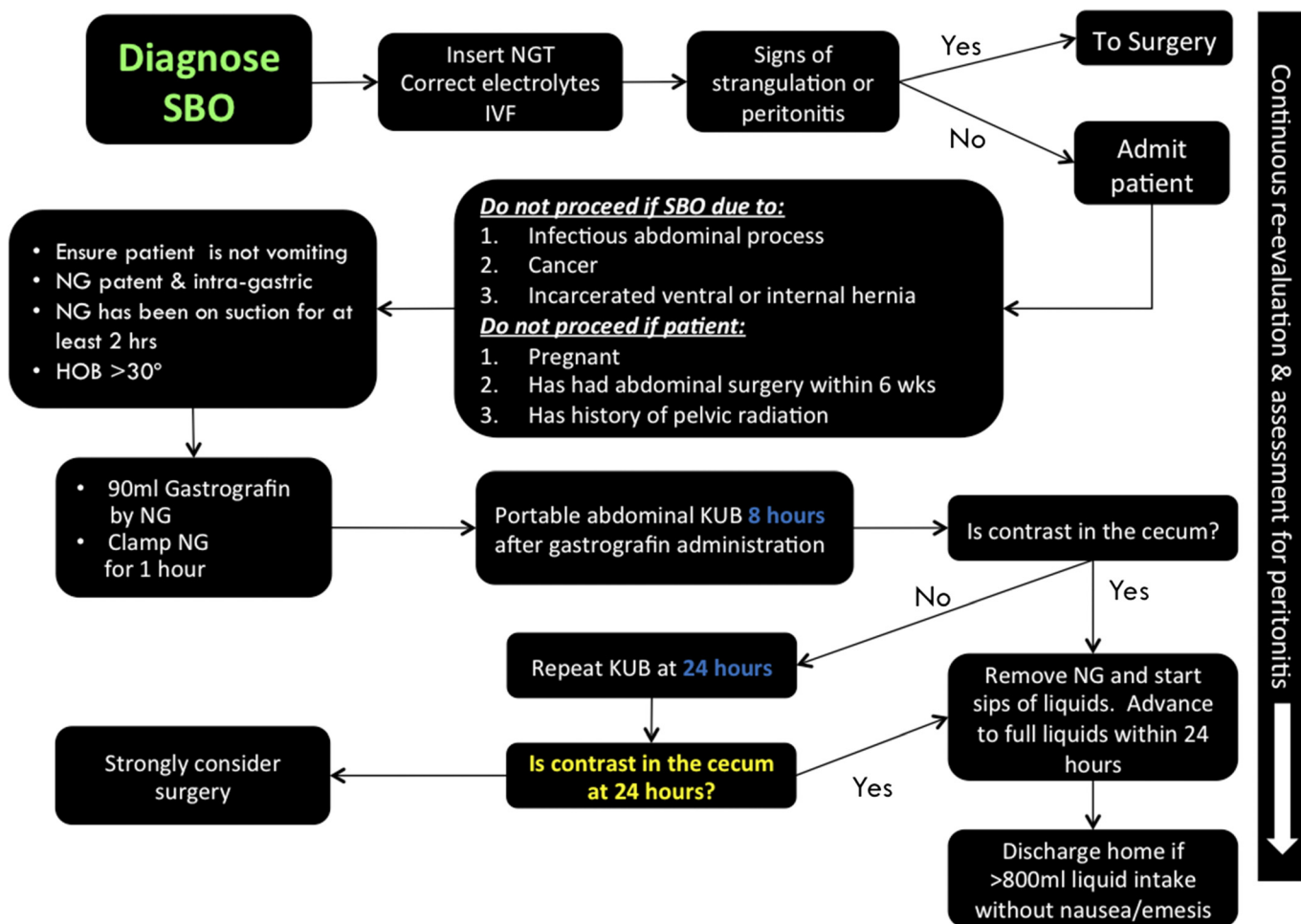
Figure 1. Decision-making flow diagram.

NGT output, pain level, or abdominal distention should lead to the removal of the NGT and feeding the patient? Does the patient need to pass flatus or bowel movement? In contrast, how many and which worsening clinical signs require operation? In addition, what should be done if a patient does not show any improvement?

In the absence of clinical signs of deterioration, recent practice guidelines recommend limiting nonoperative therapy to periods between 3 days and 5 days.[2,5] One study found an increased incidence of death and prolonged length of stay if surgery is delayed for more than 4 days.[8] There is also recognition that the rate of small bowel resection increases with longer nonoperative management.[10] Conversely, Shih et al.[11] showed that the average time to resolution is 6.9 days but can take up to 12 days. In the study of Shih et al., if a 5-day cutoff was used as the trigger for surgery, 141 of the 220 patients who eventually had spontaneous resolution of their SBO would have had unnecessary surgery. Hence, there remains debate over the duration of nonoperative management, which can lead to a period of indecision when a patient's SBO does not resolve immediately.

This period of nonoperative management and its associated uncertainty regarding the need for surgery have the potential to generate significant patient anxiety, in addition to the physical discomfort of an NGT. Furthermore, in the new climate of acute care surgery services, with frequent hand-offs between providers who likely have different individual practices, the patient may hear several different opinions from one day to the next regarding whether they need surgery and when. Moreover, frequent handoffs may lead to delay in definitive care as nonoperative management frequently does not have a clear end point or well-established indications for surgery.[2] This scenario, while becoming more common, is far from ideal; it begs for a treatment approach that will more efficiently predict which patients will resolve with nonoperative therapy and which will require surgery. The ideal approach would allow rapid triaging without compromising patient safety and preferably use existing resources. This approach would expediently identify patients who will fail nonoperative management and those who will benefit from it. Based on recent guidelines,[2,5] a review of the literature, and experience at Kaiser Permanente in Walnut Creek, California, an approach using a well-designed protocol that includes the administration of a water-soluble oral contrast would meet these criteria.
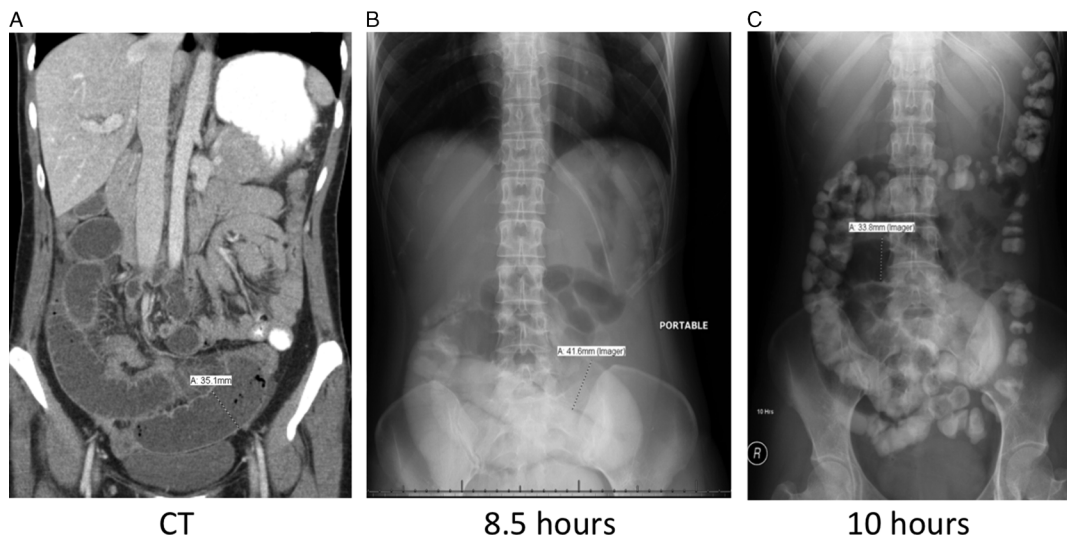
Figure 2. *A,* Patient was admitted with SBO confirmed by CT. *B,* Abdominal plain film 8.5 hours after administration of Gastrografin. *C,* Patient had bowel movement 1 hour after film in *B.* Repeat abdominal plain film shows contrast in sigmoid colon. Patient was discharged 26 hours after Gastrografin administration.

The Evidence for Water-Soluble Contrast Challenge

In 2007, the Cochrane Collaboration published a meta-analysis of 10 prospective clinical trials, enrolling patients with previous abdominal surgery who presented with evidence of SBO and without signs of ischemia.[12] Patients with operations in the preceding 6 weeks, signs of peritonitis or strangulation, carcinomatosis, or irreducible hernia were excluded. In these studies, patients had NGTs placed to suction in the emergency department, were resuscitated with IV fluids, and were given electrolyte replacement to correct any detected imbalance. Following this initial resuscitation, they were given between 50-mL and 100-mL Gastrografin orally or via NGT. The NGT, if present, was clamped for 1 hour to 3 hours, and abdominal x-rays were obtained between 4 hours and 24 hours. The presence of Gastrografin in the colon within 24 hours indicated that the obstruction would resolve without surgical intervention, with 97% sensitivity and 96% specificity. In contrast, "if the contrast does not reach the caecum [by 24 hours], the bowel obstruction is considered to be complete and it is unlikely to settle without surgical intervention."

This review found that compared with the traditional practice of "close monitoring," the use of water-soluble contrast resulted in no difference in overall complications, mortality, or rates of small bowel strangulation or resection. However, it did
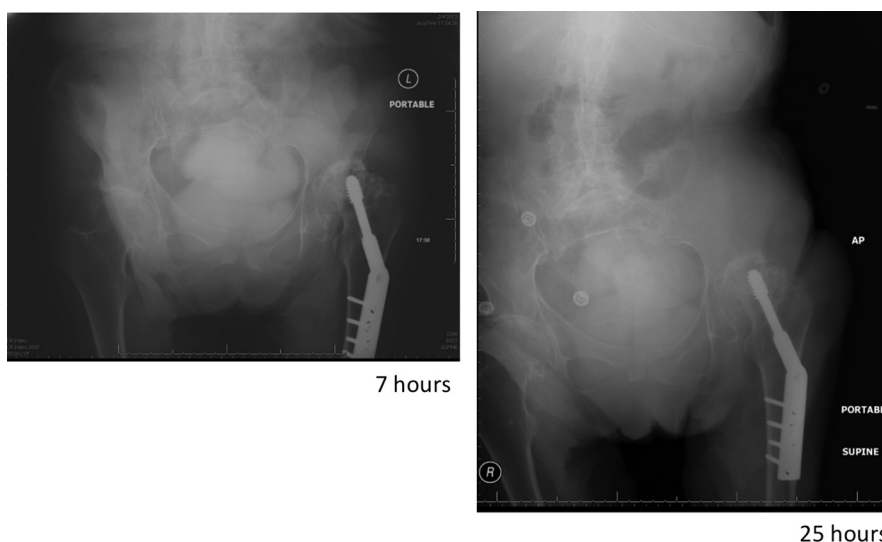
Figure 3. Abdominal plain films of a patient who failed the Gastrografin protocol because of absence of Gastrografin in the colon after 24 hours. Patient went to surgery 50 hours after Gastrografin administration and was found to have a thick band causing an internal hernia.
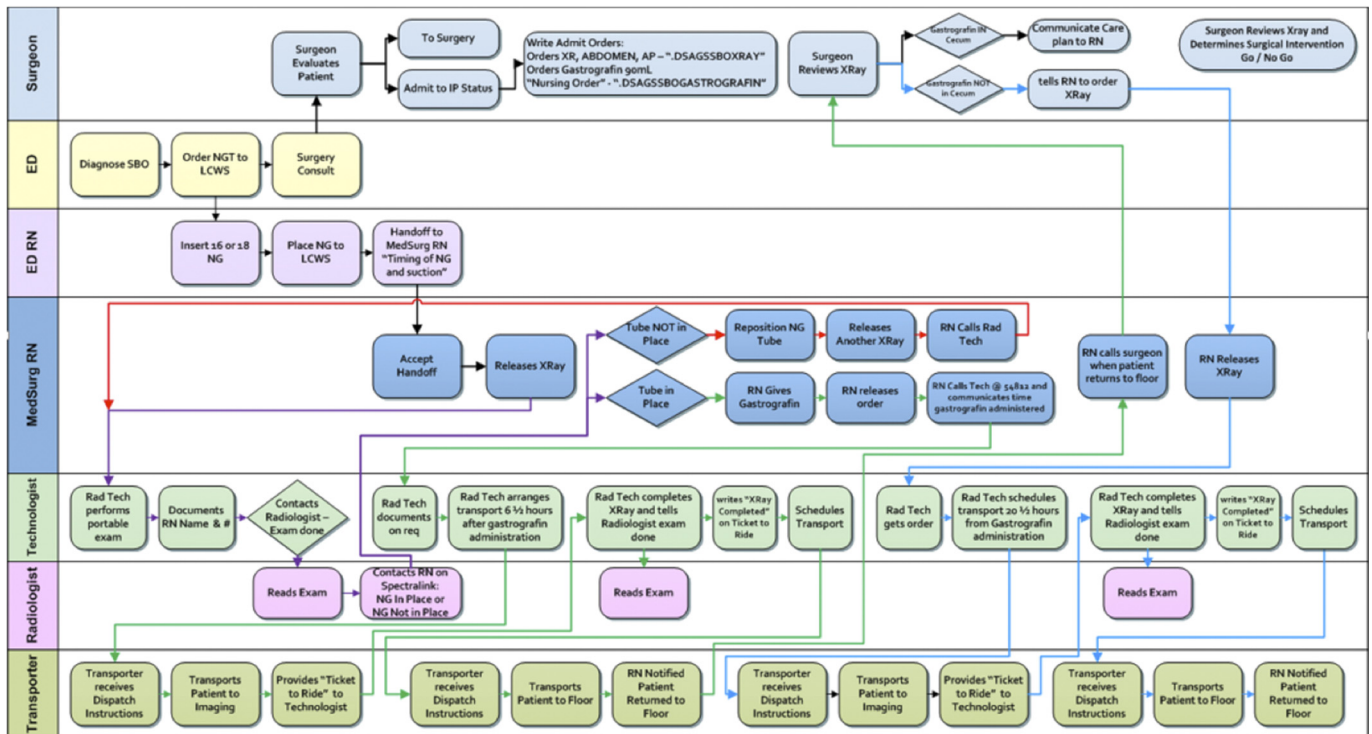
Figure 4. Flow diagram. Roles of departments involved in SBO management.

result in a statistically significant decrease in hospital length of stay, by almost 2 days in patients who received Gastrografin. The authors concluded that "the management of patients with adhesive SBO can be simplified according to whether water soluble contrast appears in the colon. This has benefits for patients by hastening surgical decision making and reducing the duration of hospital stay." Several recent studies have confirmed the benefits of using Gastrografin in the management of SBO.[13–15]

[A note on specific contrast medium is that these studies were obtained with Gastrografin contrast, which is ionic and highly osmolar.[12] These properties of Gastrografin reduce bowel wall edema and increases intraluminal tension. Newer water-soluble contrast agents are nonionic with lower osmolality; Gastrografin should be used preferentially for the SBO water-soluble contrast test.]

Using Gastrografin to Enhance Nonoperative Management

A Gastrografin-based protocol was developed at Kaiser Permanente in Walnut Creek, California (Fig. 1). When a patient presents to the emergency department with symptoms suggestive of SBO, an initial assessment with vitals, physical examination, and laboratory tests is performed. Those without an acute abdomen that necessitates urgent surgical exploration undergo CT of the abdomen and pelvis as described earlier. If there are no signs of bowel ischemia, then a trial of nonoperative management is initiated. A NGT is inserted, and placed to suction for two hour. Correct placement in the stomach is verified by an anteroposterior radiograph. Provided the patient is not actively vomiting at this point, 90-mL Gastrografin is administered per NGT, and the tube is clamped for 1 hour. It is then replaced to suction. Eight hours

after administration of Gastrografin, another x-ray is obtained. If contrast has reached the cecum, the test is considered successful; the NGT is removed, and a clear liquid diet is started. Frequently, the osmotic effect of the Gastrografin results in the patients having large bowel movements a few hours after administration, which is another confirmation that the bowel obstruction is resolving. If the Gastrografin does not reach the cecum at 8 hours, the NGT is continued to suction, and another radiograph is obtained at 24 hours after Gastrografin administration (Fig. 2). At this time, if contrast has still failed to reach the cecum, operative intervention is strongly considered (Fig. 3).

Developing a Protocol for Gastrografin Administration

Administration of enteral Gastrografin is an unfamiliar test in most hospitals. It begins in the emergency department and continues to the medical/surgical unit, during the course of 24 hours. It requires multiple abdominal x-rays, with associated transport to the radiology department and readings by the radiologist. Assurance of appropriate NGT placement is paramount to prevent administration of contrast into the lungs, either directly or by aspiration, which can be fatal.[16] A protocol aims to efficiently link all these resources, streamline initial assessment, ensure that patients with signs of strangulation or ischemia are taken directly to the operating room, and if applicable, standardize delivery of care across all physicians rotating through acute care surgery call.

Successful adoption of this protocol requires the cooperation of multiple individuals from several hospital departments. The specific details will vary from place to place because every hospital has its own unique environment. Regardless, a robust

protocol will require good interdisciplinary coordination and communication. For example, before implementation of our protocol, meetings were held with the managers and physician leaders of every involved department, to learn about their workflow and hear their concerns. From those meetings, a flow diagram of responsibilities for each department was created (Fig. 4). After implementation, challenges continued to arise on several fronts. Open dialogue and recurrent meetings have allowed the disparate departments to work together to find useful solutions.

Early Results of Protocol Implementation

Despite the obstacles mentioned earlier, implementation of this protocol has resulted in subjective and nonmeasurable improvements such as reduced surgeon anxiety, more frequent reevaluation of patients by providers at multiple levels, and less debate over the timing of surgery in patients treated nonoperatively for SBO. Furthermore, implementation of this protocol has demonstrated a very significant benefit in objective outcomes as well. Implementation was initiated in July 2013. Hospital length of stay decreased by 0.7 days for patients managed without surgery and 1.8 days for patients requiring surgery in 2014 compared with 2012 (unpublished data). No complications related to Gastrografin have occurred.

A similar protocol using Gastroview has been used at the University of Florida Health.[17] The use of the protocol provided "substantial prognostic information" by facilitating the early recognition of complete bowel obstruction. At the same time, it did not increase (or decrease) hospital length of stay, morbidity, or mortality. During a 1-year period, 91 patients presented with adhesive SBO. Twenty-four patients went immediately to surgery, 4 had resolution of SBO before Gastroview challenge, and 72 patients underwent Gastroview challenge. Of the patients who underwent Gastroview challenge, 31% (22 of 72) failed to pass Gastroview into the colon within 24 hours, and all underwent surgery subsequently. Sixty-nine percent (50 of 72) of patients in the Gastroview group passed the contrast into the colon within 24 hours. Within this group, 10% (2 of 21) of the patients who passed Gastroview within 5 hours still needed surgery, and 24% (7 of 29) of the patients who passed Gastroview between 5 hours to 24 hours required surgery. These nine patients (18%) who passed Gastroview but went on to surgery failed clinically with feeding intolerance, fever, leukocytosis, and/or physical signs of peritonitis. This small but significant cohort of patients who need surgery despite passing contrast into the colon within 24 hours indicate the need for constant clinical reassessment even when contrast is in the colon within 24 hours. Of the 41 patients discharged without surgery after passing Gastroview, 5 (12%) were readmitted with recurrent SBO. Four had resolution after being redirected through the Gastroview protocol, and one patient required surgery. In this study, there was no comparison with outcomes before instituting the Gastroview protocol.

Goussous et al.[13] at the Mayo Clinic were able to determine the effects of adding a Gastrografin protocol to an existing SBO management model. Although they also had several patients (10%) requiring operative intervention despite successful Gastrografin challenge, they demonstrated that the Gastrografin challenge added predictability to their previous model. There was a significant reduction in operative intervention (25% vs. 42%, $p = 0.05$) and a reduction in overall morbidity (13% vs. 31%, $p = 0.02$). After the introduction of the Gastrografin challenge, the average hospital length of stay was reduced by 3 days, although it did not reach statistical significance. These benefits were not accompanied by an increased risk of missed strangulation obstructions.

SURGICAL MANAGEMENT

In the setting of an initial "acute abdomen" with peritoneal signs, concerns for ischemia, and an unstable patient, laparoscopy is rarely an option. However, in the setting of nonresolving SBO based on the Gastrografin study or in selected stable patients with concern for ischemia at the time of initial or secondary assessment, laparoscopy should be seriously considered as the first line of treatment.

Laparoscopic Management

Laparoscopic management of SBO was first described in 1990.[18] Twenty-five years later, laparoscopy remains uncommonly used for surgical management of SBO. Only 15% of cases were performed laparoscopically in a recent review of more than 9,600 patients in US centers.[19] There are multiple underlying reasons: laparoscopic management of SBO is technically challenging, and by definition, the presence of adhesions from previous surgery and the lack of working space because of small bowel dilatation increase the risks of inadvertent small bowel injury. This risk should be at the forefront of any decision making regarding SBO management. However, laparoscopic management does provide significant benefits if performed safely. Three large studies (4,000–9,600 patients) have confirmed these outcomes using multivariate analyses or matched cohorts to account for patient selection. In these studies, laparoscopic adhesiolysis had reduced odds of mortality (odds ratio [OR], 0.55; $p = 0.024$), major complications (OR, 0.70; $p < 0.0001$), overall complications (OR, 0.46; $p < 0.01$), and length of stay (4 days vs. 10 days, $p < 0.001$).[19–21] A small study comparing two matched groups also demonstrated reduced total hospital charges in the laparoscopic group ($29,900 vs. $61,800, $p = 0.03$).[22] Recurrence rates over 3 years were not different between the laparoscopic group and open approach in a cohort of nearly 300 patients.[23] It should be noted however that although the groups in the studies mentioned earlier are well matched, the absence of randomization opens the risks of an initial selection bias from the surgeon at the time of deciding the approach. Conversely, it is unlikely that a large enough randomized clinical trial could be performed to provide higher-quality evidence.

So should laparoscopy be the preferred approach to SBO? Beyond the technical challenge, laparoscopic adhesiolysis is burdened by the risk of inadvertent enterotomy and, worse, of a missed enterotomy. This is, without a doubt, the biggest hamper to this approach. Multiple studies have tried to evaluate this risk. In one of the largest series of laparoscopic adhesiolysis (>500 patients), enterotomies occurred in 4.7% of cases and a missed enterotomy in 1.3%.[24] In other series, the reported rate of missed enterotomies reached a worrisome 4.8%.[25] In a comparison between 52 open and laparoscopic matched patients, the rate of enterotomies was double in the laparoscopic group (26.9% vs. 13.5%). However, one third of enterotomies in the laparoscopic group were actually made after conversion to open; this would

bring the rates to a comparable 17.3 % versus the 13.5% in the open group.[26] Lastly, trocar or Veress injury was reported to be 2% but without detailed description of the injury.[24]

Surgeons hesitant about a laparoscopic approach will likely see the high rate of conversion to open as deleterious. However, we advocate that this should not be regarded as such. First of all, the high conversion rate is dictated by multiple factors, among them the need for small bowel resection. Small targeted incisions for resection accounted for one quarter of all conversions in a recent study.[24]

As clearly outlined by Dindo et al.,[24] the reason for conversion is a crucial factor for postoperative complications. In cases of preemptive conversion, for example, because of impaired visualization or matted adhesions, the postoperative complication rate was 20.0%. This rate more than doubled to 48.6% in cases of reactive conversion following an intraoperative complication.

We therefore advocate that laparoscopy should be considered for surgical treatment of most patients with SBO. This statement should be however obviously be somewhat tempered. Studies have tried to identify risk factors for conversion to try and assist with preoperative patient selection. These factors remain obscure. A recent study and a systematic review identified the following positive predictors for laparoscopic success: a small bowel diameter of less than 4 cm, two or fewer previous laparotomies, previous surgery being an appendectomy and surgical experience.[27] Laparoscopic adhesiolysis is a beneficial approach from many standpoints, if intraoperative complications and missed enterotomies can be avoided. However, successful laparoscopic approach remains challenging to predict. This conclusion is supported by the most recent guidelines from the World Society of Emergency Surgery[2] and the Eastern Association for the Surgery of Trauma.[5]

Deciding—Laparoscopic or Open

Based on the data mentioned earlier, we offer the following operative strategy. The ideal successful surgical management should be defined as follows: laparoscopic lysis of adhesions (LOA) without inadvertent enterotomy or laparoscopic LOA with conversion to laparotomy before any intraoperative complication. In our view, the balance between precomplication conversion and conversion after complication should be viewed as a quality metric. If the conversion rate is too low, selection was too strict, and some patients who could have benefited from laparoscopic LOA underwent a laparotomy. A high precomplication conversion rate demonstrates a real attempt to provide patients with a laparoscopic approach. When attempting a laparoscopic LOA, an open access technique for initial trocar placement is advisable. Rapid conversion to open surgery is highly encouraged with the lowest possible threshold if the surgeon feels uncomfortable proceeding laparoscopically. Obviously some patients will never be adequate candidates for a laparoscopic approach (unstable patient, frozen abdomen, history of open abdomen for example). The surgeon's judgment and experience remain the essential cornerstone of this arduous decision making.

SUMMARY

The initial goal of evaluating a patient with SBO is to immediately identify strangulation and need for urgent operative intervention, concurrent with rapid resuscitation. This relies on a combination of traditional clinical signs and CT findings. In patients without signs of strangulation, a protocol for administration of Gastrografin immediately in the emergency department efficiently sorts patients into those who will resolve their obstructions and those who will fail nonoperative management. Furthermore, because of the unique ability of Gastrografin to draw water into the bowel lumen, it expedites resolution of partial obstructions, shortening time to removal of nasogastric tube liberalization of diet, and discharge from the hospital. Implementation of such a protocol is a complex, multidisciplinary, and time-consuming endeavor. As such, we cannot overemphasize the importance of clear, open communication with everyone involved.

If surgical management is warranted, we encourage an initial laparoscopic approach with open access. Even if this results in immediate conversion to laparotomy after assessment of the intra-abdominal status, we encourage this approach with a goal of 30% conversion rate or higher. This will attest that patients will have been given the highest likelihood of a successful laparoscopic LOA.

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