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SCIENTIFIC REVIEW

Non-operative Management of Small Bowel Obstruction in Patients with No Previous Abdominal Surgery: A Systematic Review and Meta-analysis

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Abstract While the contemporary management of adhesive small bowel obstruction (SBO) often includes a trial of non-operative management (NOM), surgical dogma dictates urgent operative exploration in patients without previous abdominal surgery. This dogma has been challenged by recent evidence suggesting most obstructions in this population are adhesive in nature. The objectives of this review were to evaluate the feasibility of NOM in patients with SBO and no history of previous abdominal surgery, to examine the etiologies of SBO in this population, and to explore the rate of adverse events seen following NOM. Embase, Medline, Cochrane, and Google Scholar were searched from inception to September 24, 2019. Articles reporting on NOM for SBO in patients without previous abdominal surgery and without clinical or radiographic features necessitating an emergent operation were included. Data were combined to obtain a pooled proportion of patients discharged without operation following a trial of NOM. 6 studies reporting on a total of 272 patients were included. The pooled proportion of patients discharged following NOM was 49.5% (95% CI 23.7–75.3%). Adhesions were found to be the predominant cause of obstruction. NOM did not appear to increase short-term complications. Most SBOs in patients without previous abdominal surgery are adhesive in nature and many patients can be discharged from hospital without surgery. While the short-term outcomes of NOM are acceptable, future studies are needed to address the long-term outcomes and safety of NOM as a treatment strategy for SBO in patients without previous abdominal surgery.

Introduction

Small bowel obstruction (SBO) is responsible for more than 300,000 hospital admissions and $1 billion in healthcare costs annually in the USA [1]. Obstruction may be secondary to multiple etiologies [1, 2], however, in the Western world, most cases are due to intra-abdominal

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adhesions attributable to previous abdominal surgery [3]. The adage "never let the sunrise or set on a bowel obstruction" [4] reflects the historical concern that a delay in surgical management can lead to severe complications, such as bowel necrosis, perforation and death [5]. However, over the past 20 years, it has become clear that in the absence of high-risk features, surgical intervention is not a requirement for clinical resolution of adhesive SBO. The recent introduction of water-soluble contrast media (WSCM) studies has further aided in identifying patients likely to resolve without surgery. Presently, the mainstay of non-operative management (NOM) for adhesive SBO consists of nasogastric tube decompression and supportive care [6, 7].

In cases of SBO where the patient has no history of abdominal surgery (and adhesions are perceived to be less likely), the optimal management strategy is less clear. Traditionally, emergent surgical intervention was indicated given the concern for obstructing lesions [8]. Older literature reports malignancy rates as high as 50% in patients presenting with SBO without previous abdominal surgery [9]. Decision-making in this population is further complicated by the potential for adverse events and recurrence associated with NOM, balanced against the potential morbidity, increased costs and length of stay associated with operative intervention [10–14].

More recent studies have shown that up to 75% of SBOs without an apparent cause (such as in patients without previous abdominal surgery) are actually adhesive in nature [15]. This has led contemporary groups to begin to study the effects of NOM for SBO in patients without previous abdominal surgery [10, 15–18]. However, the literature is currently limited to small, single-institution studies which make it difficult to evaluate this treatment strategy [10, 15–18]. The objectives of this review were to evaluate the feasibility of NOM in patients with SBO and no history of previous abdominal surgery, to examine the etiologies of SBO in this population, and to explore the rate of adverse events seen as a result of NOM.

Materials and methods

In this systematic review and meta-analysis, PRISMA guidelines [19] were followed throughout (Supplemental Table 1). The protocol for this review was registered prospectively with PROSPERO (CRD42019132445)[20].

Outcomes

The primary outcome for this review was the pooled proportion of SBO patients without previous abdominal surgery, who experienced resolution of SBO with NOM (defined as discharge from hospital without surgery). Secondary outcomes included the use of WSCM, a common adjunct to NOM, etiologies of SBO, rates of SBO recurrence, rates of adverse events and length of hospital stay (LOS).

Search strategy and study selection

We conducted online searches of the Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Embase and Medline, each from inception to September 24, 2019. A search of the first 10 pages of Google Scholar results was also conducted. The search terms employed for this review were designed with the assistance of an information specialist (Supplemental Table 2). No patient-age restrictions were applied to the searches. Only English language results were considered. The reference lists of included studies were reviewed for additional relevant citations.

All randomized controlled trials, observational studies and case series with at least 10 patients were included. This threshold was selected to balance the need to perform a thorough review of the literature with need to minimize the uncertainty around outcome estimates attributable to studies with small sample sizes. Abstracts and conference proceedings were not included due to the potential for selective reporting bias, the fact that data collection and analysis may be incomplete when these publications are prepared, and the often-prohibitive lag time between preparation of these manuscripts and their eventual publication [21].

We included studies that described NOM (nasogastric decompression and/or administration of WSCM) for the treatment of SBO in patients without previous abdominal surgery. We required that included studies did not include clinically unstable patients, those with peritonitis, and those with evidence of incarcerated hernias or closed-loop obstruction as these patients warrant urgent surgical intervention and are not appropriate for a trial of NOM. Subsets of patients from included studies that did not undergo a trial of NOM were excluded.

Zotero software [22] was used to manage citations and identify duplicates. 2 reviewers (ZB and MG) independently screened the titles and abstracts of all studies identified by our search. The same reviewers independently reviewed the full text of all relevant studies and applied the described inclusion and exclusion criteria. Rayyan software [23] was used to track reviewer decisions. All disagreements were resolved by consensus among the 2 reviewers. When necessary, the reviewers contacted study authors to obtain additional information.

Data collection

Data were extracted using a form created in Microsoft Excel. We collected the total number of SBO patients without previous abdominal surgery treated with NOM from each study, as well as the number of those patients that were discharged from hospital without an operation. We also collected data on the use of WSCM, the etiology of obstruction, hospital LOS, incidence and types of adverse events and rates of recurrence, where available.

Risk of bias

Risk of bias was assessed using the Newcastle–Ottawa scale [24] for cohort studies and the International Health Economics (IHE) Quality Appraisal Checklist [25] for case series. The latter tool was modified, as per IHE standards, by removing questions which were inapplicable to our study (questions 13 and 17). Risk of bias assessments was conducted independently by ZB and MG, and disagreements were resolved by discussion. Scoring was conducted as-per published guidelines [26] Case series were considered to have a low risk of bias if greater than 80% of criteria were met, moderate risk of bias if 50–80% of criteria were met, and high risk of bias if less than 50% of criteria were met [27, 28]. We planned to assess for the existence of publication bias using a funnel plot if at least 10 studies were included in the review.

Data synthesis and statistical analysis

Outcome measures were pooled using the Open Meta Analyst software package, employing the restricted maximum likelihood method, and a random effects model [29] Heterogeneity was assessed using the I^2 statistic [30] Sensitivity analyses were planned to exclude studies found to have significant differences in conduct compared to the majority of included studies.

Results

Identified studies

Our search strategy identified 1318 citations. After deduplication, 913 unique citations were screened using titles and abstracts. We identified 46 citations which warranted a full-text reviews, however, attempts to contact the authors of 3 abstracts, with the goal of obtaining the full texts were unsuccessful, so these citations were excluded [31–33] After reviewing the full text of 43 studies, 6 were found to have met all inclusion criteria—2 retrospective cohort studies [10, 34] and 4 case series (initial reviewer agreement, $\kappa = 0.71$) [16, 17, 35, 36] No additional studies were identified by hand searching the references of studies selected for full review (Fig. 1). A total of 272 patients were included in the analysis (Table 1).

Description of studies

Each of the included studies specifically excluded patients with a clear mechanical cause of SBO such as a hernia, volvulus, phytobezoar, or obvious obstructing mass. The reported proportion of SBOs in patients without previous abdominal surgery that resolved without an operation following a trial of NOM ranged from 0% (0/10) [34] to 84% (37/44) (Table 1) [16].

Three of the 6 included studies reported on the use WSCM in the NOM of SBO [10, 16, 36]. In each study, patients were administered WSCM at the time of presentation. In one study, WSCM was shown to decrease the rate of surgical intervention from 49% (32/65) to 17% (6/36) in SBO patients without previous abdominal surgery [10] In two others, passage of WSCM into the colon predicted discharge without an operation in 97% (37/38) [16] and 100% (10/10) [36] of patients.

Two of the included studies reported on the etiologies of SBO observed. In patients undergoing therapeutic operations and for whom a definitive diagnosis could be made, adhesions were the most common cause of obstruction, occurring in 53% (23/43) [17] and 45% (13/29) [35] of patients. Other etiologies are detailed in Table 2. These proportions include all patients without previous abdominal surgery that were treated operatively for SBO and are not limited to those that first underwent a trial of NOM. The majority of patients (83%, 19/23) with adhesions confirmed intraoperatively in one study had congenital bands as opposed to diffuse adhesions [17].

Although only the aforementioned studies report specifically on etiology, the proportion of patients found to have malignancy at the time of operation can be ascertained in four of the six included studies (Collom, Ng, Strajina, Chung). In these studies, collectively, 14/149 (9%) of patients were found to have malignancy at the time of operation. Furthermore, 20% (2/10) of patients who were discharged without surgery following NOM in one study [35] were found to have an intra-abdominal malignancy on subsequent screening, although, in this study, 40% of patients who underwent operative exploration had no etiology for their SBO identified.

Two studies reported the proportion of patients with a recurrence of their SBO following initial discharge after NOM. In one study, recurrence was 13% (8/60) in the first year [35] and in the second recurrence was 3% (1/29), although the time period over which this was measured was not reported [17]. Finally, a third study [10] found that 13%

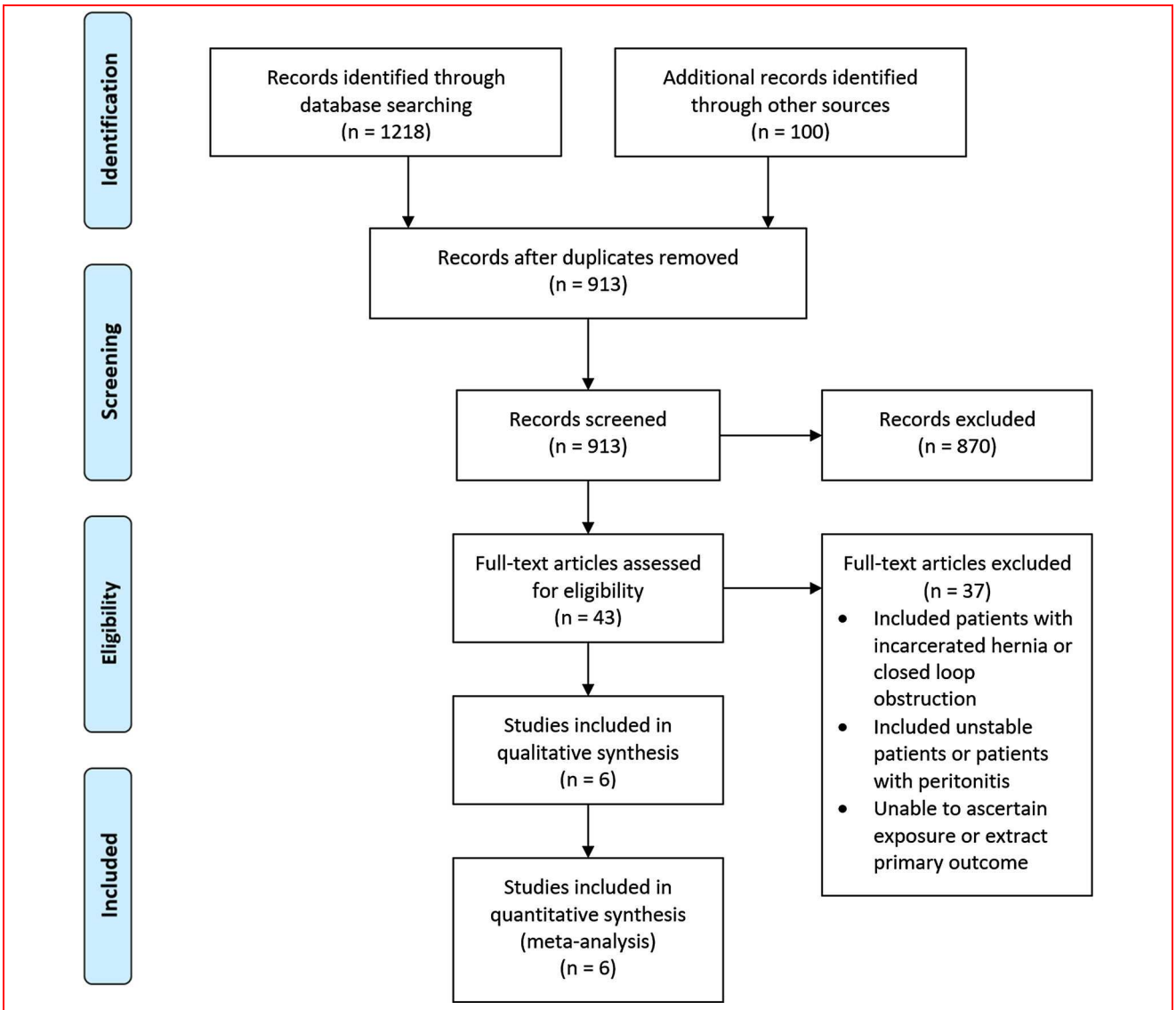

Fig. 1 PRISMA flow diagram [19]—study selection and screening process

(13/101) of patients treated with NOM were readmitted within 30-days, though not all readmissions were attributable to recurrence. This study found no significant difference between the 30-day readmission rates for patients with no previous abdominal surgery and patients with a history of prior surgery ($p = 0.76$).

With respect to complications, one study [10] reported that 3% (3/101) of patients treated with NOM suffered intestinal perforation and 16% were admitted to the ICU. There was no significant difference in the rate of perforation or ICU admission between patients with no previous abdominal surgery and patients with a history of prior surgery ($p = 0.74$ and $p = 0.28$, respectively). A second study reported that 7% (3/44) of patients aspirated secondary to the administration of WSCM [16] Finally, in a third study, 22% (13/60) of patients experienced 30-day morbidity, including aspiration pneumonia and surgical site infection [35] In this same study, 6 patients were found to have a closed-loop obstruction that was not identified on preoperative CT imaging.

Median LOS after NOM was only reported by one study [17] and was found to be 5 days. This was significantly lower than the LOS for patients treated operatively, which was 7 days ($p < 0.01$).

Risk of bias

The retrospective cohort studies by Collom and Butt [10, 34] were found to be of "good" quality, while the 4 case series [16, 17, 35, 36] were found to have a "moderate" risk of bias (Table 1).

Table 1 Characteristics of studies included in review, including risk of bias assessment decisions and proportions of patients without previous abdominal surgery that were discharged after NOM for SBO

Name	Year	Country	Type	Exposure	Discharged/total NOM patients (%)	Overall risk of bias/ quality
Chung, *ANZ J Surg*	1996	Hong Kong	Case series	NOM for SBO after WSCM administration	10/17 (58.8%)*	Moderate
Butt, *World J Surg*	2009	USA	Cohort study	Unidentified adhesional SBO	0/10 (0%)	Good
Ng, *ANZ J Surg*	2018	Singapore	Case series	NOM for SBO	29/40 (72.5%)	Moderate
Fukami, *World J Surg*	2018	Japan	Case series	NOM for SBO after WSCM administration	37/44 (84.1%)*	Moderate
Collom, *J Trauma Acute Care Surg*	2018	USA	Cohort study	NOM for SBO after WSCM administration	62/101 (61.4%)*	Good
Strajina, *Am J Surg*	2019	USA	Case series	NOM for SBO	10/60 (16.7%)	Moderate
Total					148/272 (54.4%)	

*Study involving the use of water-soluble contrast administration in the management of SBO

NOM non-operative management, *SBO* small bowel obstruction, *WSCM* water-soluble contrast media

Table 2 Etiology of small bowel obstruction in patients without previous abdominal surgeries, for all patients with definitive etiologies established at the time of operation, from studies reporting on this outcome

Etiology	Ng, *ANZ J Surg.*, 2018 $n = 43$	Strajina, *Am J Surg.*, 2019 $n = 29$
Abscess	0 (0%)	1 (3%)
Adhesions	23 (53%)	13 (45%)
Bezoar	3 (7%)	2 (7%)
Gallstone ileus	5 (12%)	0 (0%)
Inflammatory changes/stricture	1 (2%)	5 (17%)
Internal hernia	4 (9%)	0 (0%)
Intussusception	2 (5%)	0 (0%)
Meckel's diverticulum	1 (2%)	1 (3%)
Small bowel volvulus	2 (5%)	2 (7%)
Tumor	2 (5%)	5 (17%)

Meta-analysis

Combining the results of all 6 included studies yielded a pooled proportion of patients whose obstruction resolved with NOM of 49.5% (95% CI 23.7–75.3%, $p < 0.001$) (Fig. 2). Considerable heterogeneity (I^2 96.4%, $p < 0.001$) was noted.

Two of the included studies had methodological inconsistencies and, as a result, a sensitivity analysis was conducted in which the results of these studies were excluded from the meta-analysis. The study by Strajina had a non-therapeutic laparotomy rate of 42% [35]. Given this high rate of non-therapeutic laparotomy and a lack of clarity in this study's methods as to the threshold for immediate surgery, it raises a strong possibility that not all patients in the study received an adequate trial of NOM, relative to patients included in other studies. The study by But [34] included only patients with a diagnostic code for peritoneal adhesions rather than a more general diagnosis of intestinal obstruction. This approach excluded patients for whom an etiology for SBO was not firmly established by the time of discharge, for example, because their obstruction resolved spontaneously without an operation, and differs from the population of other studies. The sensitivity analysis excluding these 2 studies yielded a pooled proportion of patients whose obstruction resolved with

NOM of 70.4% (58.5–82.2%, $p < 0.001$) (Fig. 3). Although greatly decreased, a substantial amount of heterogeneity remained (I^2 69.0%, $p = 0.014$).

Overall quality of evidence

There were insufficient studies to construct a funnel plot to visually assess for publication bias. It did appear, though, that small studies [34, 36] and studies with both high and low rates of discharge after NOM [34, 35] were published.

Discussion

This systematic review and meta-analysis evaluated the success of NOM in patients with SBO and no prior abdominal surgery. We have demonstrated that 50–70% of patients without previous abdominal surgery who present with SBO can be discharged home without an operation. At present, surgical dogma holds that all patients without previous abdominal surgery that present with SBO merit immediate surgery. Our review demonstrates that a trial of NOM is feasible in a significant proportion of these patients. These findings align with the current treatment paradigm for adhesive SBO, whereby patients without concerning physical exams or imaging features of bowel compromise are given a trial of NOM.

These same guidelines encourage the use of WSCM in the workup of adhesive SBO as a tool for ruling out the need for surgical intervention. In the studies evaluated in this review which included the administration of WSCM, the passage of contrast into the colon was highly predictive of SBO resolution without the need for surgery. In this way, once again, patients presenting with and no previous abdominal surgery seem to follow a similar course to patients who have undergone previous abdominal surgery.

In the studies by Ng [17] and Strajina [35], half of all patients presenting with no previous abdominal surgery were found to have adhesions as the cause of their SBO at the time of operation. A study by Beardsley et al. [15] reported that three quarters of patients without previous abdominal surgery that were treated operatively for SBO had adhesive SBO. Taken together, these studies indicate that more than half of all patients with SBO in the setting of no previous abdominal surgery have adhesive SBO. This finding, as well as that of Collom who found no increase in adverse events with NOM [10], could provide justification for clinicians to consider managing SBO in the patients without previous abdominal surgery similarly to adhesive SBO in those with a history of prior abdominal surgery, assuming no alternative etiologies are identified on history, examination and imaging.

The study by Collom [10] reported that 13% of SBO patients without previous abdominal surgery who were discharged from hospital after NOM were readmitted within 30 days, however, not all readmissions represented recurrent SBO and readmission rates were similar for patients with a history of previous surgery. Strajina [35], on the other hand, reported a one-year recurrence rate of 13%. Previous observational studies have demonstrated that patients treated non-operatively for adhesive SBO had an 8% higher lifetime risk of recurrent SBO compared to patients managed operatively, with a 5-year cumulative recurrence incidence of 19% [37]. Given the high rates of recurrence seen in SBO patients without previous surgery who were treated with NOM and the similarly high recurrence rates seen following NOM for adhesive SBO, clinicians must weigh the risk of SBO recurrence against the benefits of avoiding surgery in select patient populations before pursuing a course of NOM.

Of the 149 patients with definitive etiologies for obstruction established in the included studies, 14 patients (9%) were found to have a malignancy. It is, therefore, prudent to screen patients treated with NOM following discharge so that occult malignancies are not missed. To date, there are no evidence-based follow-up screening

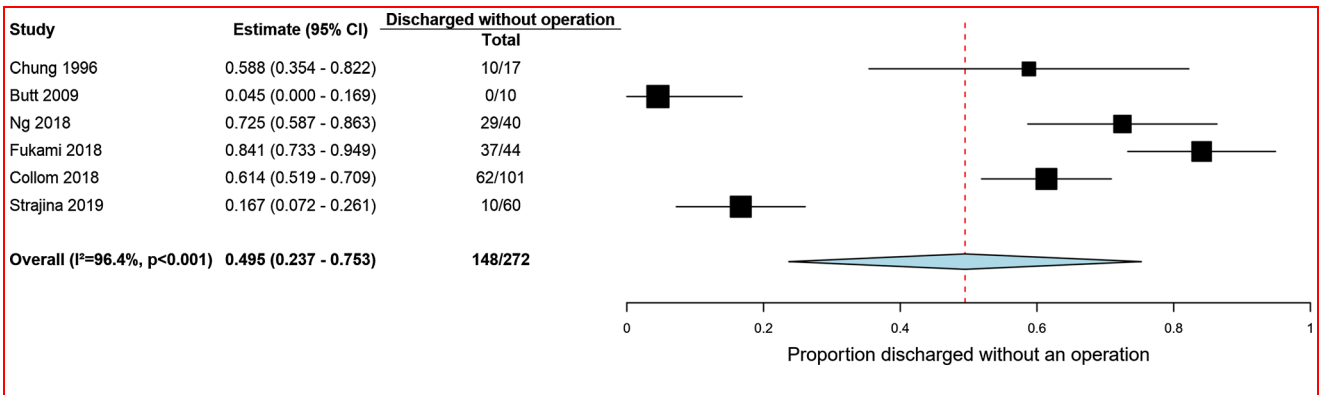

Fig. 2 Primary analysis—pooled proportion of patients with no history of abdominal surgery whose obstruction resolved with NOM

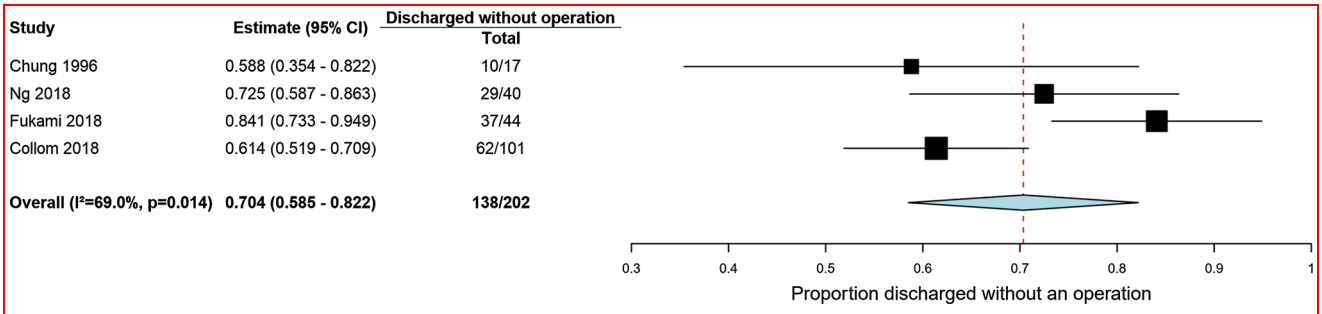

Fig. 3 Secondary analysis—pooled proportion of patients with no history of abdominal surgery whose obstruction resolved with NOM excluding methodologically inconsistent studies by Strajina and Butt

protocols for this population, and none of the included studies employed uniform post-discharge screening tests. The authors of this review consider colonoscopy and CT or MR enterography for SBO patients without previous abdominal surgery who discharged after NOM. Screening can take place once the patient has fully recovered from their obstruction, usually in the 4–6 weeks following discharge. While colonoscopy remains the gold standard for screening the colon, CT and MR enterography, respectively, have been found to be 85% and 91% sensitive for small bowel lesions in recent studies [38, 39]. Capsule endoscopy represents another minimally invasive approach to screening. In selected patients, diagnostic laparoscopy could be performed in the interval after discharge, when the risk of inadvertently injuring distended bowel is lower, to further evaluate for occult causes of SBO.

Although this review attempts to summarize the extent of the evidence for NOM of SBO in patients without previous abdominal surgery, there is a paucity of published evidence on this topic and the small number of patients in this review represents a significant limitation. Furthermore, our findings are driven by small, single-arm studies. These case series may be more reflective of local practice patterns and may not completely reflect broader surgical practice. The unusually high rate of negative laparotomies in the study by Strajina [35], for example, is a manifestation of this limitation which we attempted to mitigate through sensitivity analysis. Nonetheless, the heterogeneity of the included studies' NOM protocols (e.g., intermittent use of WSCM, non-standardized threshold for operation) is another limitation of this meta-analysis. However, this variability represents the reality in which medicine is practiced by diverse groups of surgeons worldwide. It should be noted, however, that heterogeneity between patients in this review was minimized—all included studies were comprised solely of stable adult patients presenting without evidence of peritonitis, hernia, or closed-loop obstructions. These are the marginal patients in whom the appropriateness of current surgical dogma is questioned and equipoise regarding optimal management exists.

In addition to heterogeneity in the protocols for NOM employed by the included studies, this review is further limited by the heterogeneity in reporting of secondary outcomes. Etiology is of paramount importance in determining the treatment approach to a patient with SBO, and few of the included studies reported specifically on the etiologies encountered in patients who required an operation.

In conclusion, this review demonstrates that 50–70% of patients with SBO and no previous abdominal surgery can be discharged from hospital after NOM and that WSCM accurately predicts the ability to discharge without operation in this patient population. Furthermore, the majority of SBOs in patients without previous abdominal surgery are adhesive in nature. However, while the short-term outcomes of NOM are acceptable, this treatment strategy must be offered to selected patients accompanied by close clinical monitoring, follow-up and screening for occult malignancies. Future studies are needed to evaluate long-term outcomes such as lifetime recurrence, need for reoperation and quality of life to assess the appropriateness of NOM as a treatment strategy for SBO in patients without previous abdominal surgery.

Author contributions PK and JS conceived the study question and ZB and MG conducted the literature review and drafted the manuscript. All authors participated in data analysis and critical review.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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