Efficacy and timing of gastrografin administration after ileus tube insertion in patients with adhesive small bowel obstruction

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Abstract

Background: Gastrointestinal decompression through ileus tube is useful for the treatment of adhesive small bowel obstruction (ASBO). Gastrografin administration through the ileus tube is performed if decompression therapy fails to relieve obstruction. However, the efficacy and appropriate timing of gastrografin administration are unclear. This study aimed to evaluate the efficacy of gastrografin administration within 48 h after admission. Methods: This retrospective study used the data of patients with ASBO admitted to our hospital between January 2014 and August 2018 and included those who underwent ileus tube intubation but did not achieve obstruction relief for over 24 h after admission. The patients were classified into the following two groups: those treated with gastrografin administration within 48 h after admission (EGA group) and those treated without gastrografin administration within 48 h after admission (non-EGA [NEGA] group). Propensity-score matching was performed to compensate for confounding differences between the groups. The short-term outcomes including the rate of successful conservative management without surgery, the period until the first stool, the period of ileus tube intubation, the total period of hospital admission, and adverse events due to gastrografin administration were evaluated and compared between the two groups. Results: This study included 152 patients: 67 in the EGA group and 85 in the NEGA group. Fifty-five pairs were matched with similar background characteristics. After matching, the rates of successful conservative management were 89.1% (49/55) and 94.5% (52/55) in the matched EGA and NEGA groups, respectively (P=0.49). Although the median insertion days of ileus tube in the NEGA group were significantly lesser than those in the EGA group (7 [5–9] vs. 5 [4.5–7], P=0.017), other therapeutic outcomes did not differ significantly. In the NEGA group, 5.5% (3/55) achieved obstruction relief without gastrografin administration. Aspiration pneumonia occurred in one patients of EGA group. Conclusions: Gastrografin administration with ileus tube achieved a high rate of successful conservative management. Follow-up by decompression with ileus tube for at least 48 h after admission is required in patients with ASBO, which may avoid unnecessary gastrografin administration and consequently reduce the total cost of treatment.

Background

Acute small bowel obstruction is usually associated with postoperative adhesion. Patients with clinical evidence of adhesive small bowel obstruction (ASBO), except those with suspected strangulation, have been treated conservatively [1]. Gastrointestinal decompression using an ileus tube or a nasogastric tube is considered to be an effective treatment in such patients [2]. A previous randomized controlled trial showed that the relief of clinical symptoms and improvement in the findings of abdominal radiography were quicker with an ileus tube than with a nasogastric tube [3]. Therefore, gastrointestinal decompression using an ileus tube is the first treatment choice in patients with ASBO at our hospital. Ileus tube insertion is usually performed on the first day of hospital admission in these patients.

However, we sometimes experience failure in relieving obstruction with only gastrointestinal decompression using an ileus tube. Surgery is considered in these patients, but this approach might have high burden among patients. If gastrointestinal decompression fails to relieve obstruction, gastrografin is

often administered through the ileus tube [4]. Gastrografin is a hyperosmolar water-soluble contrast medium; therefore, the status of small bowel obstruction can be evaluated with gastrografin administration. The ileus tube can be inserted deeper because gastrografin administration is usually performed under continuous radiography. Furthermore, gastrografin administration has been suggested to have a therapeutic effect, which was reported to reduce the need for surgery in some previous reports [4-6]. In addition to gastrointestinal decompression using an ileus tube, gastrografin administration could be effective for treatment when conservative therapy fails [4]. Therefore, we usually administer gastrografin via the ileus tube if the obstruction does not improve over 12–24 h after ileus tube intubation. However, the evidence of gastrografin administration as a treatment for ASBO is insufficient. Furthermore, the appropriate timing of gastrografin administration is unknown. Gastrografin administration at an early stage might be associated with earlier improvement compared with insufflation at a later stage or no insufflation. In contrast, gastrografin administration at an early stage might be considered as excessive treatment because some patients might show relief of obstruction with only ileus tube intubation. Therefore, the present study aimed to evaluate therapeutic outcomes of gastrografin administration at an early stage within 48 h after admission, with a propensity-score matching analysis to compensate for the confounding bias [7, 8].

Methods

Patients and study approval

This retrospective study used the data of patients older than 18 years with acute small bowel obstruction admitted to the Division of Gastroenterology, Department of Internal Medicine, Nihon University School of Medicine between January 2014 and August 2018. The inclusion criteria were as follows: (1) presence of clinical symptoms and physical signs associated with acute small bowel obstruction such as abdominal pain, distention, nausea, and vomiting without stool production; (2) diagnosis of ASBO on radiography with computed tomography (CT), which was confirmed by no less than two clinicians or radiologists (Figure 1a, b); and (3) admission to the Department of Gastroenterology at our hospital within one day after symptom onset. The exclusion criteria were as follows: (1) emergency surgery for suspected strangulation; (2) large bowel obstruction, cancer peritonitis, obstructed abdominal wall, groin hernia, active inflammatory bowel disease including suspected Crohn's disease; (3) early postoperative small bowel obstruction within 4 weeks after surgery; (4) successful treatment without any decompression therapy; (5) successful treatment using a nasogastric tube; and (6) successful treatment using an ileus tube without gastrografin administration within 24 h after admission. If patients had two or more admissions during the study period, the first admission was considered. Patients were classified into the following two groups: (1) those treated with gastrografin administration within 48 h after admission (early gastrografin administration group; EGA group) and (2) those treated without gastrografin administration within 48 h after admission (nonearly gastrografin administration group; NEGA group). Some patients were treated with gastrografin administration after 48 h following admission and others were treated without gastrografin administration during the entire hospital stay.

Ileus tube insertion and gastrografin administration

All enrolled patients underwent gastrointestinal decompression within 24 h after admission. The CLYNY single or double-balloon type tube (Create Medic, Tokyo, Japan) was used as an ileus tube for decompression of the gastrointestinal tract. The length and outer diameter were 300 cm and 5.3 mm (16 Fr), respectively. The ileus tube was inserted using endoscopy and/or continuous radiography with a guidewire (350 cm or 500 cm in length and 1.32 mm in diameter). In the endoscopic insertion method, the guidewire was inserted into the duodenum through the main channel of a trans-nasal ultrathin endoscope (GIF-XP260N; Olympus, Tokyo, Japan). After removal of the endoscope, the ileus tube was inserted through the guidewire, reaching at least the upper jejunum (Figure 2). A small amount of gastrografin was used to obtain contrast images of the small intestinal tract during ileus tube intubation. Patients who failed to insert ileus tube were switched to the treatment with nasogastric tube. Such patients were excluded from this study. After insertion, gastrointestinal decompression was performed via the ileus tube, without any oral intake. Gastrografin was administered if clinical remission could not be achieved; the ileus tube could not be removed because no clinical improvement was identified, which was considered as the disappearance of abdominal symptoms with stool production. Administration was preformed through the ileus tube (Figure 3). The amount of gastrografin at one administration was 150 ml. If possible, the ileus tube was advanced to the anal side. It was then clamped for 1–2 h after gastrografin administration. Gastrografin administration was sometimes repeated when improvement was not achieved over 24 h after the previous administration. In the EGA group, the first gastrografin administration was performed within 24–48 h after hospital admission. In the NEGA group, decompression was continued using an ileus tube without gastrografin administration for at least 48 h after admission. If clinical improvement was not achieved for over 48 h, gastrografin administration was considered, as in the EGA group.

Data collection

Clinical variables, including age (year, median [interquartile range: IQR]), sex (male/female), height (cm, median [IQR]), weight (kg, median [IQR]), body mass index (BMI: kg/m^2, median [IQR]), type and number of prior surgeries (single/multi), and laboratory test indexes on admission (WBC count: /μl, median [IQR], CPR level: mg/dl, median [IQR]), were compared between the EGA and NEGA groups.

Outcome measures

The aim of decompression therapy or gastrografin administration was clinical remission without surgery due to ASBO. Therefore, the study outcomes were the rate of successful conservative management without surgery, the period until the first stool, the period of ileus tube intubation, and the total period of hospital admission. Clinical improvement was defined as disappearance of abdominal symptoms with stool production. After confirming clinical improvement, the ileus tube was clamped and then drinking or liquid food was started. Thereafter, the ileus tube was removed after confirming the absence of symptom recurrence over 24 h. Clinical remission was considered if the ileus tube could be removed. Discharge

criterion was the achievement of remaining clinical improvement with taking soft or normal food over 48 h after tube removal. In contrast, patients eventually underwent surgery if clinical improvement was not achieved with decompression therapy and gastrografin administration during admission. Patients who showed no clinical improvement in the initial 48 h after admission were consulted by surgeons. Surgery was finally performed if the clinical symptoms worsened or strangulation was suspected. If allergic reaction, aspiration pneumonia, and renal failure occurred after gastrografin administration, they were considered as adverse events related to gastrografin administration [4, 5, 9].

Statistical analysis

The sample size was calculated based on the expected rate of successful conservative management, which was the primary outcome. We estimated 70% in the NEGA group according to the previous reports. We hypothesized that an additional effect of 20% in the EGA group constituted a clinically relevant improvement of EGA over NEGA. A required sample size of 98 patients was then calculated considering a 2-sided α error of 0.05 and β error of 0.2. There were confounding biases between the two study groups, as this was a nonrandomized study. Thus, propensity-score matching analysis, which has been used to compensate for confounding factors, was adopted in this study [10-12]. Logistic regression of factors, including background characteristics, and propensity score were calculated. Age (<70 years vs. ≥70 years), sex (male vs. female), number of surgeries (multiple vs. others), type of surgery (gastrointestinal vs. others), height (<160 cm vs. ≥160 cm), weight (<50 kg vs. ≥50 kg), BMI (<21 kg/m^2 vs. ≥21 kg/m^2), white blood cell count (<10000/μl vs. ≥10000/μl), C-reactive protein level (<0.5 mg/dl vs. ≥0.5 mg/dl), and method of ileus tube insertion (endoscopy with radiography vs. radiography) were included in covariate analysis. Nearest-neighbor matching in a 1:1 ratio from the EGA and NEGA groups was performed in calipers (0.11) with a width equal to 0.25 of the standard deviation of the logit of the propensity score. Results are expressed as median [IQR] for continuous data distributed abnormally. Fisher's exact test and the Mann–Whitney test were used to identify differences in categorical data and continuous data distributed abnormally, respectively. All statistical analyses were performed using JMP Pro 13.0 software (SAS Institute, Cary, NC, USA). A P-value <0.05 was considered statistically significant. The sample size could not be calculated owing to the retrospective nature of this study.

Results

Background characteristics before matching

A total of 169 patients were treated using ileus tube insertion as first-line therapy in this study. Of these, 17 patients immediately achieved relief of obstruction within 24 h after admission. Therefore, 152 patients were included in this study. Flowchart of patient enrollment is shown in Figure 4. The background characteristics of the enrolled patients are presented in Table 1. Then, 67 were included in the EGA group and 85 were included in the NEGA group. Among all patients, the median age was 69 (IQR, 56.8–79) years, and 44.7% (68/152) of the patients were male. The most common previous surgical type was gastrointestinal surgery (35.5%, 54/152). The median height, weight, and BMI were 158.0 (IQR, 152–

164) cm, 51.5 (IQR, 44–60) kg, and 20.5 (18.3–22.7) kg/m^2, respectively. In first-line treatment, endoscopy with radiography was used for ileus tube insertion in 31.6% (48/152) of the patients. The insertion time was evaluated in 82 patients (35 patients from the EGA group and 47 patients from the NEGA group). The median insertion time was 37 (IQR, 29.4–46.5) min. There were no significant differences in the factors between the two groups.

Study outcomes before propensity-score matching

Therapeutic outcomes before propensity-score matching are presented in Table 2. A total of 11 patients underwent surgery because conservative therapy did not achieve clinical remission. The rates of successful conservative management without surgery were 89.6% (60/67) in the EGA group and 95.3% (81/85) in the NEGA group, and there was no significant difference between the groups (P = 0.22). In the NEGA group, 5.9% (5/85) of patients were successfully treated without gastrografin administration. The median period until the first stool and median period of hospital admission were not significantly different between the EGA and NEGA groups (median period until the first stool [IQR]: 3 [2–4] vs. 3 [2–3] days, P = 0.51; median period of hospital admission: 12.5 [9.25–14] vs. 11 [9–15] days, P = 0.14). However, the median period of ileus tube intubation was significantly shorter in the NEGA group than in the EGA group (7 [5–8] vs. 5 [4–7] days, P = 0.007).

One patient, a 79-year-old female in the EGA group experienced fever on the next day after gastrografin administration. She was diagnosed with aspiration pneumonia based on X-ray and blood test results. She was treated with antibiotic therapy. No aspiration pneumonia occurred in the NEGA group. In addition, no other adverse events occurred in both groups.

Propensity-score matching and matching factors between the study groups

Propensity-score matching was performed, and 55 pairs were obtained in this study. The C-statistic was estimated to be 0.64, indicating good predictive power. The matching factors after propensity-score matching are shown in Table 3. No factor was significantly different between the two groups. In addition, all absolute standardized difference ranges were within $1.96\sqrt{2/n}$, which indicated that the characteristics were well balanced.

Study outcomes after propensity-score matching

Therapeutic outcomes after propensity-score matching are presented in Table 4. The rates of successful conservative management without surgery were 89.1% (49/55) in the matched EGA group and 94.5% (52/55) in the matched NEGA group, and there was no significant difference between the groups (P = 0.49). In the matched NEGA group, 5.5% (3/55) of patients were successfully treated without gastrografin administration. The median period until the first stool and median period of hospital admission were not significantly different between the matched EGA and NEGA groups (median period until the first stool [IQR]: 3 [2–4] vs. 3 [2–3] days, P = 0.27; median period of hospital admission: 12 [9.5–14.5] vs. 11 [8.5–

14.5] days, P = 0.20). However, the median period of ileus tube intubation was significantly shorter in the matched NEGA group than in the matched EGA group (7 [5–9] vs. 5 [4.5–7] days, P = 0.017).

Discussion

This was the first study to evaluate the efficacy of early gastrografin administration after ileus tube insertion. The present study found that gastrografin administration with gastrointestinal decompression by ileus tube achieved quite a high rate of successful conservative management without surgery in patients with ASBO. However, early gastrografin administration was not superior to nonearly gastrografin administration with regard to the improvement in clinical outcomes among patients with ASBO.

With regard to the treatment of acute small bowel obstruction, the most important factor is the exclusion of bowel strangulation, which requires immediate surgery [4], and the mortality rate in such patients has been reported to be over 30% when the period from onset to surgery is over 36 h. Thus, overlooking strangulation can result in a very serious situation. Enhanced CT is useful to assess the blood flow in the ileum. Emergency surgery was performed in 37 patients with acute small bowel obstruction at our hospital during study period; 33 patients were suspected of strangulation and 4 patients were at the discretion of the surgeons. Strangulation was observed in 16 patients during surgery. Finally, 21 patients required partial bowel resection.

Conservative management to avoid surgery should be selected only in patients with obstruction who do not have bowel strangulation. The ileus tube is frequently selected for gastrointestinal decompression. However, there have conventionally been clinical concerns with regard to the technical difficulty associated with the insertion of a long intestinal tube under radiography, which requires a long time and involves a high radiation dose. Recently, many types of useful tube insertion methods have been reported, and they allow easy insertion of an ileus tube in patients with small bowel obstruction [13-18]. Treatment using an ileus tube should be selected in patients with small bowel obstruction owing to its usefulness and high effectiveness. An ileus tube might not be selected in some patients at the discretion of the doctor because of a poor general condition or a history of clinical remission without an ileus tube. With regard to the use of ileus tube insertion as first-line therapy in this study, 10.1% (17/169) of all identified patients treated using the ileus tube immediately achieved relief of obstruction for only one day.

Gastrografin reduces the edema of the gastrointestinal wall thorough absorption of water owing to its high osmotic pressure. Its therapeutic efficacy for ASBO was expected when conservative therapy using an ileus tube failed. Two recent meta-analyses have reported the therapeutic efficacy of gastrografin administration [6, 19]. One meta-analysis suggested the efficacy of gastrografin administration in reducing the need of surgery in patients with ASBO as well as predicting the need of surgery. While, another meta-analysis showed that gastrografin administration could not reduce the need of surgery. Therefore, its efficacy was controversial according to the previous meta-analysis. In this study, 147 of the 152 included patients underwent gastrografin administration before matching. Although 11 patients finally underwent surgery because of conservative therapy failure, successful conservative management

was achieved in 141 patients (92.8%). Therefore, gastrografin administration with the gastrointestinal decompression by ileus tube contributed to a low rate of surgery. Furthermore, if 17 excluded patients who had successful treatment using an ileus tube alone without gastrografin administration within 24 h after admission were added to the included patients in this study, the rate of successful conservative management without surgery increased up to 93.5% (158/169). Previous studies reported that the success rate with conservative management using an ileus tube was 74%–81.1% [16, 20]. The success rate in the present study was higher than that in these previous studies, and this might be because of the increased efficacy with the addition of gastrografin administration.

We hypothesized that gastrografin administration at an early stage might contribute to better outcomes of conservative therapy for small bowel obstruction. However, in this study, the final surgical rate did not differ between the EGA and NEGA groups. The period until the first stool and total period of hospital admission were not significantly different between the two groups. In contrast, the period of ileus tube intubation was significantly longer in the EGA group than in the NEGA group. Furthermore, 5.5% (3/55) of patients in the NEGA group after matching (5.9%, 5/85 before matching) were successfully treated without gastrografin administration. Therefore, we could not confirm the superiority of early gastrografin administration within 48 h after admission. On the contrary, early gastrografin administration, the opportunity to relieve ileus without gastrografin administration might be missed. The results suggest that gastrografin administration might not be as important as gastrointestinal decompression in the early stage of small bowel obstruction. Gastrografin has a high osmolarity (1900 mOsm/l), and it induces water movement from the gastrointestinal wall to the lumen. Although gastrografin administration reduces edema, it increases the amount of fluid in the lumen, which might reduce the efficacy of decompression by an ileus tube. Gastrografin administration might be performed after sufficient decompression by an ileus tube, which might contribute to a reduction in the total cost, including the cost of materials and staff for gastrografin administration.

With regard to the adverse events, aspiration pneumonia occurred in one patient of the EGA group. Gastrografin might have been vomited and aspirated as a result of administration without relieve of small bowel obstruction, although gastrografin could assist in releasing its obstruction. This patient was treated with conservative therapy, and no other patients showed adverse events. Considering the low rate of adverse events in this study, gastrografin administration through the ileus tube was considered as a safe treatment for patients with ASBO.

During the study period, overall, 48 patients underwent surgery, and 37 of these patients underwent surgery without conservative therapy mainly because strangulation was suspected at the initial diagnosis. The remaining 11 patients were included in this study and underwent surgery because consecutive treatment using ileus tube did not achieve clinical remission. Of these 11 patients, 9 only required adhesion dissection and 2 required not only adhesion dissection but also partial small intestine resection owing to strangulation. The average (median) period of conservative therapy was 5 (8.9) days. Only one patient showed relapse of acute small bowel obstruction after surgery, but the obstruction was relieved with conservative therapy. Other patients were followed-up without recurrence of small bowel

obstruction. Surgical treatment should be considered in patients who do not achieve clinical remission with only conservative therapy, including gastrointestinal decompression by an ileus tube and gastrografin administration.

The present study has some limitations. First, this was a retrospective study without randomization. Therefore, there might have been bias with regard to the selection of the treatment strategy. There was a possibility that early gastrografin administration was conducted for patients with severe condition. To reduce this bias, propensity-score matching was performed, and it was found that the treatment outcomes did not differ between before and after matching. Second, two types of ileus tubes were used in this study. One has only one balloon attached to the edge to the tube sheath, whereas the other has two balloons. Thus, the efficacy of gastrointestinal decompression might differ between the two types of tubes, and such a difference might affect the treatment outcomes. Third, the length of insertion and the amount of output from ileus tube were not evaluated in this study. These factors might affect the treatment outcomes. Fourth, patients with ASBO just after no clinical improvement in the initial 48 h after admission was consulted by surgeons and surgery was considered in this study. This strategy was similar to the previous studies [4, 9]. However, a recent study suggested a significant proportion of small bowel obstructions require >48 h to resolve after gastrografin administration [21]. Although some patients continued to take conservative treatment before surgery, others underwent surgery soon after their consultation with surgeons. Continuation of conservative management for >48 h might have helped avoid surgery. The efficacy of gastrografin administration might not have been fully evaluated. Fifth, we aimed to evaluate the efficacy of adding gastrografin administration with an ileus tube and its appropriate timing for patients who did not have successful treatment using an ileus tube. Therefore, we excluded those patients who had successful treatment using ileus tube without gastrografin administration within 24 h after admission. As a result of exclusion, we might have underestimated the rate of successful conservative management especially for the NEGA group. We additionally showed the rate of successful conservative management for all patients adding excluded patients. The direct comparison of the treatment outcomes of included patients with those of other study should be taken care of. Sixth, we could not evaluate the presence of the contrast agent in the colon after gastrografin administration because this study was a retrospective one without a definite protocol for evaluation. It is a good prediction marker for the need of surgery in patients with ASBO. Therefore, a prospective randomized controlled trial should be performed in the future to clarify the efficacy and the most appropriate timing of gastrografin administration after ileus tube insertion.

Conclusions

Conservative approaches, including gastrointestinal decompression using an ileus tube and reduction of edema of the gastrointestinal wall through gastrografin administration, can help relieve acute small bowel obstruction without strangulation, which might contribute to a high rate of successful conservative management without surgery. However, early gastrografin administration might not be superior to nonearly gastrografin administration. Gastrografin administration after gastrointestinal decompression

by ileus tube at least 48 h from admission might be appropriate in the treatment of acute small bowel obstruction.

List Of Abbreviations

ASBO = adhesive small bowel obstruction

BMI = body mass index

CT = computed tomography

IQR = interquartile range

Declarations

Ethics approval and consent to participate: This study and the opt-out form of informed consent were approved by the Institutional Review Board at Nihon University School of Medicine (RK-180911-17). Informed consent was obtained in the form of opt-out on the web-site. Those who rejected were excluded.

Consent for publication: Not applicable

Availability of data and materials: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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References

1. Seror D, Feigin E, Szold A, Allweis TM, Carmon M, Nissan S, et al. How conservatively can postoperative small bowel obstruction be treated? Am J Surg. 1993;165:121-5; discussion 125-6.
2. Gowen GF. Long tube decompression is successful in 90% of patients with adhesive small bowel obstruction. Am J Surg. 2003;185:512-15.
3. Chen XL, Ji F, Lin Q, Chen YP, Lin JJ, Ye F, et al. A prospective randomized trial of transnasal ileus tube vs nasogastric tube for adhesive small bowel obstruction. World J Gastroenterol. 2012;18:1968-74.

4. Choi HK, Chu KW, Law WL. Therapeutic value of gastrografin in adhesive small bowel obstruction after unsuccessful conservative treatment: a prospective randomized trial. Ann Surg. 2002;236:1-6.
5. Branco BC, Barmparas G, Schnuriger B, Inaba K, Chan LS, Demetriades D: Systematic review and meta-analysis of the diagnostic and therapeutic role of water-soluble contrast agent in adhesive small bowel obstruction. Br J Surg. 2010;97:470-78.
6. Ceresoli M, Coccolini F, Catena F, Montori G, Di Saverio S, Sartelli M, et al. Water-soluble contrast agent in adhesive small bowel obstruction: a systematic review and meta-analysis of diagnostic and therapeutic value. Am J Surg. 2016;211:1114-25.
7. D'Agostino RB, Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Stat Med. 1998;17:2265-281.
8. Austin PC. Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. Stat Med. 2009;28:3083-107.
9. Farid M, Fikry A, El Nakeeb A, Fouda E, Elmetwally T, Yousef M, et al. Clinical impacts of oral gastrografin follow-through in adhesive small bowel obstruction (SBO). J Surg Res 2010;162:170-6.
10. Esaki M, Suzuki S, Hayashi Y, Yokoyama A, Abe S, Hosokawa T, et al. Splash M-knife versus Flush Knife BT in the technical outcomes of endoscopic submucosal dissection for early gastric cancer: a propensity score matching analysis. BMC Gastroenterol. 2018;18:35.
11. Hayashi Y, Esaki M, Suzuki S, Ihara E, Yokoyama A, Sakisaka S, et al. Clutch Cutter knife efficacy in endoscopic submucosal dissection for early gastric neoplasms. World J Gastrointest Oncol. 2018;10:487-95.
12. Esaki M, Suzuki S, Hayashi Y, Yokoyama A, Abe S, Hosokawa T, et al. Propensity score-matching analysis to compare clinical outcomes of endoscopic submucosal dissection for early gastric cancer in the postoperative and non-operative stomachs. BMC Gastroenterol. 2018;18:125.
13. Sato R, Watari J, Tanabe H, Fujiya M, Ueno N, Konno Y, et al. Transnasal ultrathin endoscopy for placement of a long intestinal tube in patients with intestinal obstruction. Gastrointest Endosc. 2008;67:953-57.
14. Li S, Yuan C, Xu MD. Two different endoscopic long intestinal tube placements for small bowel obstruction: Transnasal ultrathin endoscopy versus conventional endoscopy. J Cancer Res Ther. 2015;11 Suppl:C248-52.
15. Sekiba K, Ohmae T, Odawara N, Moriyama M, Kanai S, Tsuboi M, et al. A new method for insertion of long intestinal tube for small bowel obstruction: Nonendoscopic over-the-wire method via short nasogastric tube. Medicine (Baltimore). 2016;95:e5449.
16. Yamaguchi D, Ikeda K, Takeuchi Y, Kinoshita R, Higuchi T, Fukuda H, et al. New insertion method of transnasal ileus tube for small bowel obstruction: Anterior balloon method. PLoS One. 2018;13:e0207099.
17. Yamaguchi D, Morisaki T, Tsunada S. Effective insertion method of transnasal ileus tube for adhesive small bowel obstruction. Dig Endosc. 2018;30:120-21.

18. Kanno Y, Hirasawa D, Fujita N, Noda Y, Kobayashi G, Ishida K, et al. Long intestinal tube insertion with the ropeway method facilitated by a guidewire placed by transnasal ultrathin endoscopy for bowel obstruction. Dig Endosc. 2009;21:196-200.
19. Koh A, Adiamah A, Chowdhury A, Mohiuddin MK, Bharathan B. Therapeutic role of water-soluble contrast media in adhesive small bowel obstruction: a systematic review and meta-analysis. J Gastrointest Surg. 2019.
20. Tanaka S, Yamamoto T, Kubota D, Matsuyama M, Uenishi T, Kubo S, et al. Predictive factors for surgical indication in adhesive small bowel obstruction. Am J Surg. 2008;196:23-7.
21. Mulder MB, Hernandez M, Ray-Zack MD, Cullinane DC, Turay D, Wydo S, et al. A significant proportion of small bowel obstructions require >48 hours to resolve after gastrografin. J Surg Res. 2019;233:408-12.

Tables

Table 1. Background characteristics of the enrolled patients

	All n = 152	EGA group n = 67	NEGA group n = 85	P-value
, median (year) [IQR]	69 [56.8–79]	70 [56.5–79]	68 [59–77]	0.82
male, n (%)	68 (44.7)	30 (44.8)	38 (44.7)	1
gical type, n (%)				0.65
strointestinal	54 (35.5)	29 (43.3)	25 (29.4)	
lbladder and pancreas	8 (5.3)	3 (4.5)	5 (5.9)	
patic and splenic	2 (1.3)	1 (1.5)	1 (1.2)	
ıecological	25 (16.4)	9 (13.4)	16 (18.8)	
ological	3 (2.0)	1 (1.5)	2 (2.4)	
ers or none	34 (22.4)	12 (17.9)	22 (25.9)	
lti	26 (17.1)	12 (17.9)	14 (16.5)	
ti-surgery	26 (17.1)	12 (17.9)	14 (16.5)	0.83
ght, median (cm) [IQR]	158.0 [152–164]	158 [153–163.5]	158 [152–166]	0.89
ght, median (kg) [IQR]	51.5 [44–60]	51 [46.5–58]	52 [54–61]	0.82
, median (kg/m^2) [IQR]	20.5 [18.3–22.7]	20.2 [18.6–22.7]	20.7 [18.0–22.9]	0.86
C count, median (/μl) [IQR]	9850 [7675–12225]	10500 [7950–12550]	9600 [2100–11900]	0.51
level, median (mg/dl) [IQR]	0.33 [0.1–1.45]	0.5 [0.1–1.58]	0.3 [0.1–1.0]	0.43
hods of insertion				0.86
loscopy with	48 (31.6%)	22 (32.8%)	26 (30.6%)	
ography	104 (68.4%)	45 (67.2%)	59 (69.4%)	
liography				
rtion time, median (min) [IQR]	(n = 82) 37 [29.3–46.5]	(n = 35) 34 [36–42.5]	(n = 47) 39 [31–52]	0.083

EGA, early gastrografin administration; NEGI, non-early gastrografin administration; IQR, interquartile range; WBC, while blood cell; CRP, C-reactive protein

P-value was calculated using Fisher’s exact test for categorical data.

P-value was calculated using the Mann–Whitney *U* test for continuous data distributed abnormally.

Table 2. Clinical outcomes in the study groups before matching

	All n = 152	EGA group n = 67	NEGA group n = 85	P-value
trografin administration, n (%)	147 (96.7)	67 (100)	80 (94.1)	0.067
cessful conservative management, n(%)	141 (92.8)	60 (89.6)	81 (95.3)	0.22
gery, n (%)	11 (7.2)	7 (10.4)	4 (4.7)	0.22
od until the first stool, median (days) R]	3 [2–4]	3 [2–4]	3 [2–3]	0.51
od of ileus tube intubation, median rs) [IQR]	6 [5–8]	7 [5–8]	5 [4–7]	0.007
od of hospital admission, median (days) R]	11 [9–14]	12.5 [9.25–14]	11 [9–15]	0.14
erse event, n (%)	1 (0.7)	1 (1.5)	0 (0)	0.44

EGA, early gastrografin administration; NEGA, non-early gastrografin administration; IQR, interquartile range

P-value was calculated using Fisher's exact test for categorical data.

P-value was calculated using the Mann–Whitney *U* test for continuous data distributed abnormally.

Table 3. Matching factors between the two study groups after propensity-score matching

	EGA group n = 55	NEGA group n = 55	P-value	ASD
able matching between the groups				
ge, years; <70/≥70	25/30	29/26	0.57	0.15
ex; male/female	23/32	24/31	1	0
urgery; multiple/others	44/11	44/11	1	0
urgery type; gastrointestinal/others	22/33	24/31	0.85	0.074
eight, cm; <160/≥160	22/33	24/31	0.85	0.074
eight, kg; <50/≥50	31/24	31/24	1	0
MI, kg/m^2; <21/≥21	23/32	22/33	1	0.037
BC count, μl; <10000/≥10000	30/25	28/27	0.85	0.073
RP level, mg/dl; <0.5/≥0.5	28/27	26/29	0.85	0.073
ethods of insertion; endoscopy with diography/radiography	19/36	19/36	1	0

EGA, early gastrografin administration; NEGA, non-early gastrografin administration; WBC, while blood cell; CRP, C-reactive protein; ASD, absolute standardized difference

P-value was calculated using Fisher's exact test for categorical data.

P-value was calculated using the Mann–Whitney *U* test for continuous data distributed abnormally.

Table 4. Clinical outcomes in the study groups after matching

	EGA group n = 55	NEGA group n = 55	P-value
trografin administration, n (%)	55 (100)	52 (94.5)	0.24
cessful conservative management, n (%)	49 (89.1)	52 (94.5)	0.49
gery, n (%)	6 (10.9)	3 (5.5)	0.49
od until the first stool, median (days) [IQR]	3 [2-4]	3 [2-3]	0.27
od of ileus tube intubation, median (days) [IQR]	7 [5-9]	5 [4.5-7]	0.017
od of hospital admission, median (days) [IQR]	12 [9.5-14.5]	11 [8.5-14.5]	0.20
erse event, n (%)	1 (1.8)	0 (0)	1

EGA, early gastrografin administration; NEGA, non-early gastrografin administration; IQR, interquartile range

P-value was calculated using Fisher's exact test for categorical data.

P-value was calculated using the Mann–Whitney *U* test for continuous data distributed abnormally.

Figures

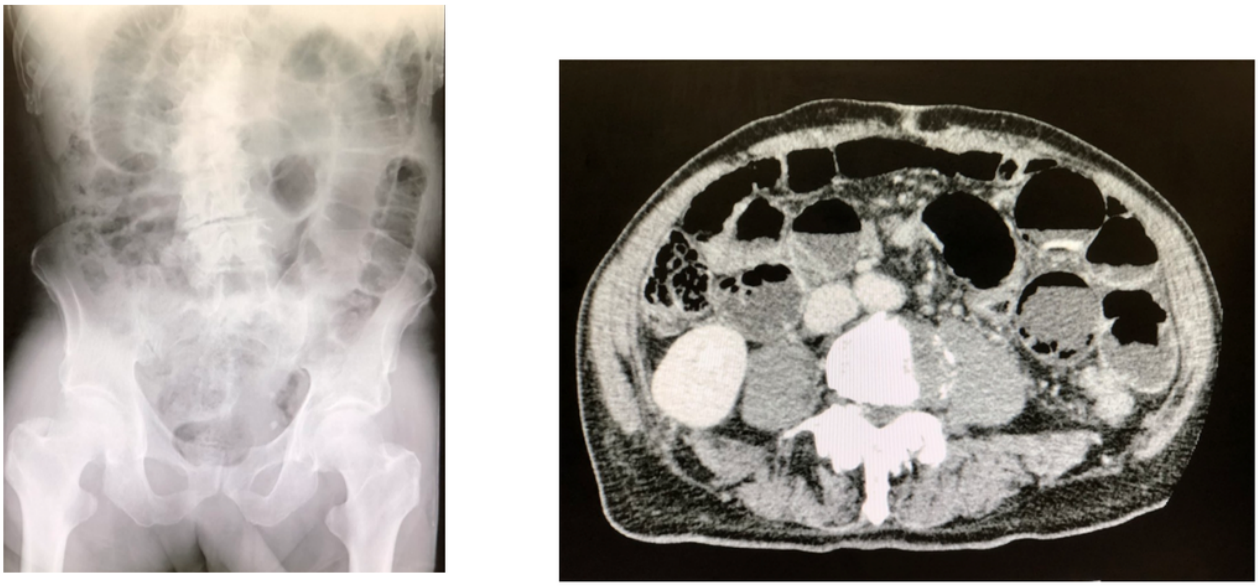

Figure 1

The images of patients with acute small bowel obstruction a. Radiography of patients with acute small bowel obstruction b. Computed tomography of patients with small bowel obstruction

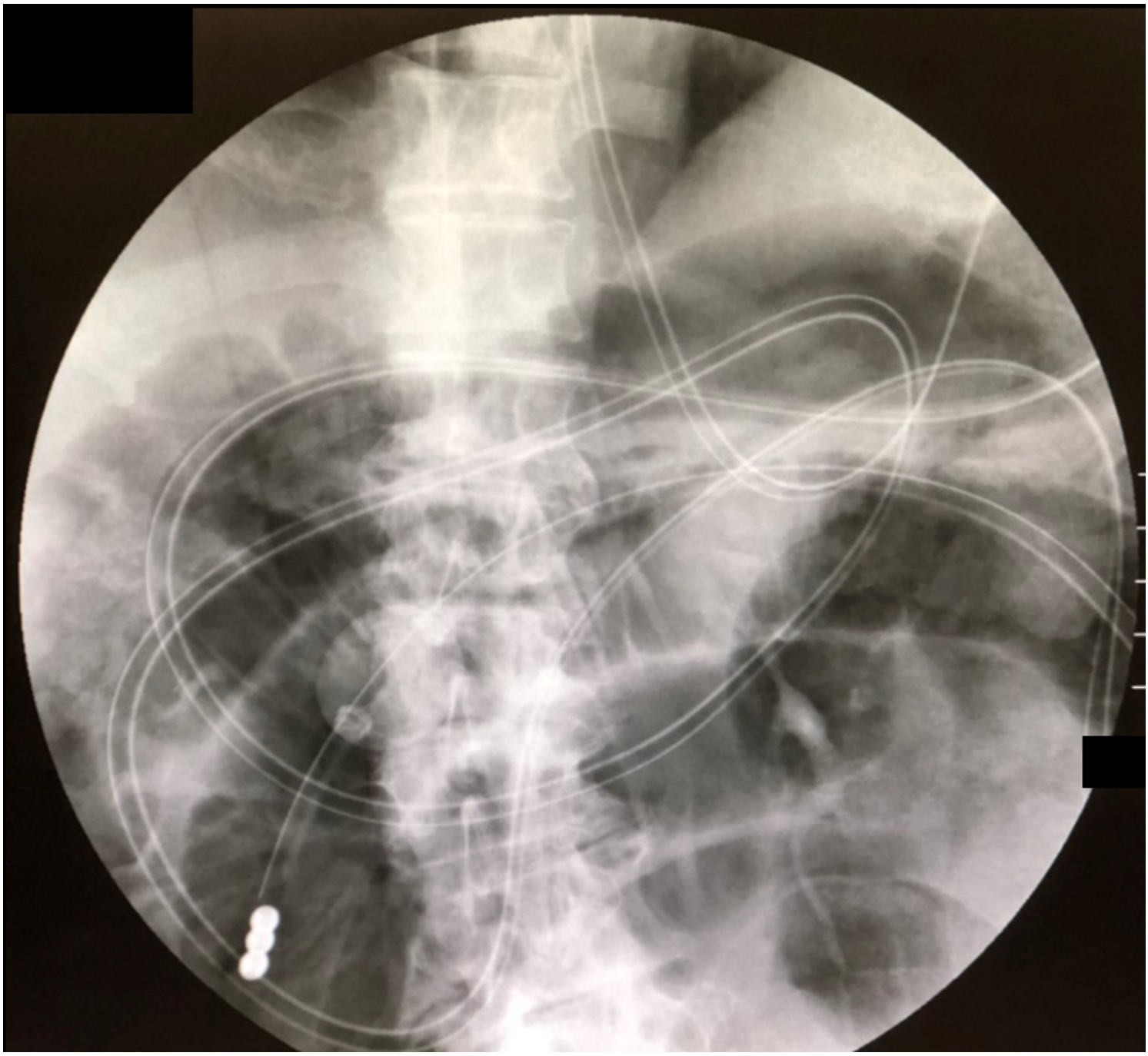

Figure 2

Radiograph after insertion of an ileus tube into the jejunum

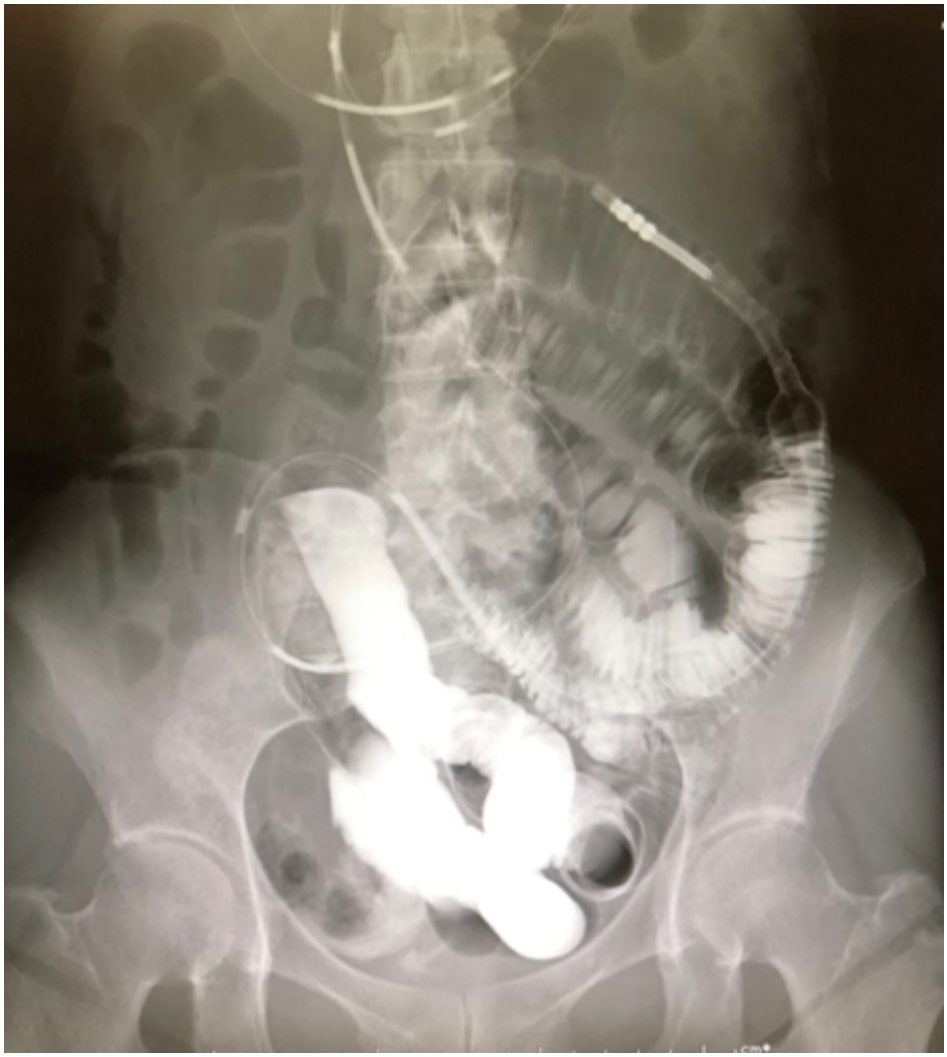

Figure 3

Radiograph of gastrografin administration through the ileus tube

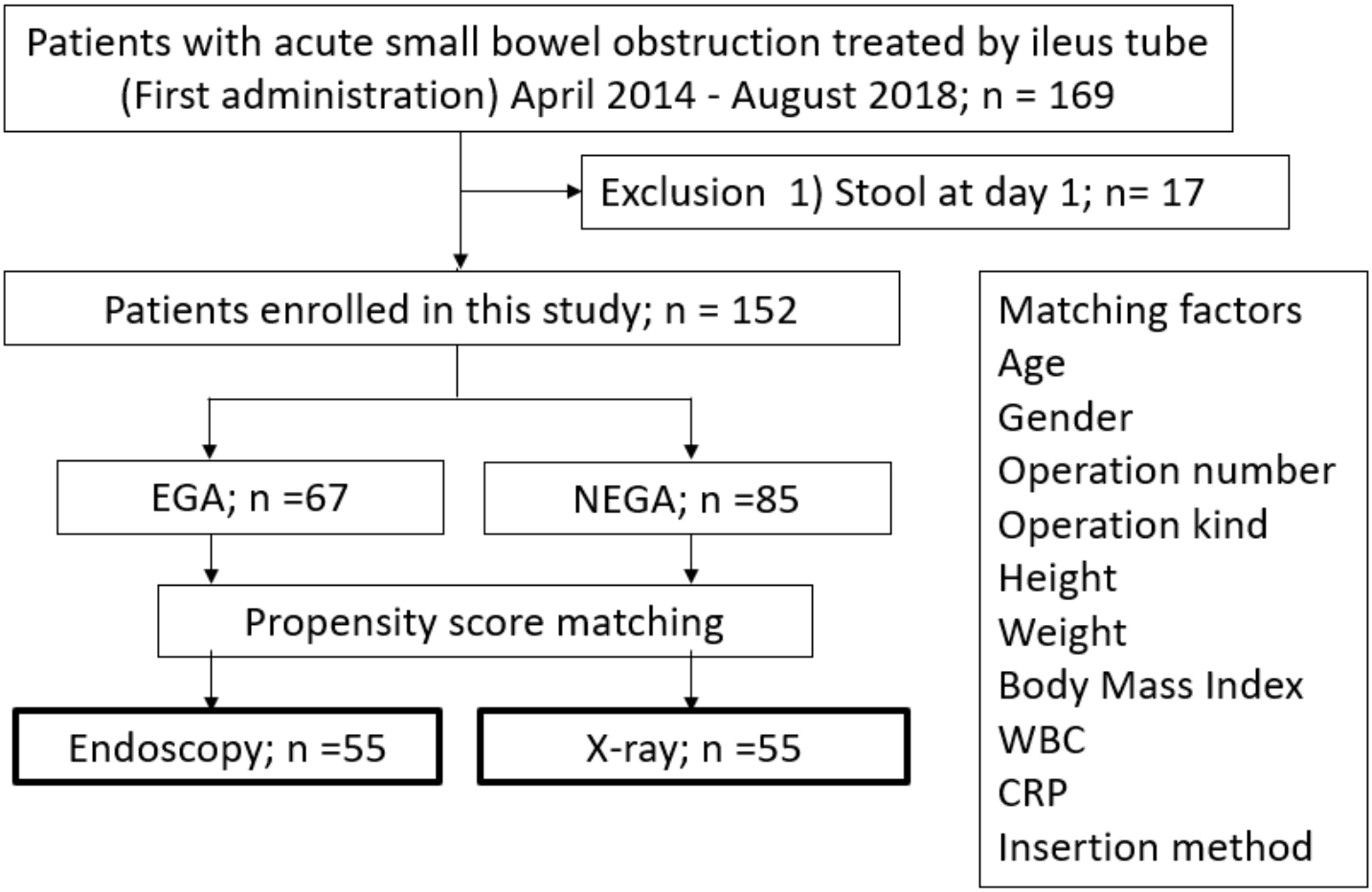

Figure 4

Flowchart of patient enrollment in this study