A new method for insertion of long intestinal tube for small bowel obstruction
Nonendoscopic over-the-wire method via short nasogastric tube

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Abstract
It is often difficult to insert a long intestinal tube (LT) in patients with small bowel obstruction (SBO). We developed a novel technique for inserting an LT without endoscopy called nonendoscopic over-the-wire method via short nasogastric tube (NEWSt). We evaluated the efficacy and safety of NEWSt.

We performed a retrospective study of patients who underwent LT insertion for SBO without any indications of strangulation with either NEWSt (n = 16) or endoscopy (n = 17) between November 2011 and February 2015 at our hospital. Univariate analysis was used to assess the success rate of LT placement beyond the duodenojejunal flexure, time required for the procedure, clinical outcomes, and adverse events.

The success rate was 100% in both groups. Procedure time was numerically, but not statistically, shorter in the NEWSt group compared with the endoscopy group (24 ± 13 vs 30 ± 13 min; P = 0.174). There were no statistically significant differences between the 2 groups in terms of surgery rate (31% vs 12%; P = 0.225), fasting period (11.3 ± 6.3 vs 9.9 ± 4.5 days; P = 0.482), hospital stay (26.4 ± 22.1 vs 18.7 ± 7.0 days; P = 0.194), and recurrence rate (19% vs 24%; P = 1.0). No serious adverse event was observed in the NEWSt group, whereas serious aspiration pneumonia was observed in 2 patients after LT insertion in the endoscopy group.

Without endoscopy, NEWSt enabled the high success rate and the short procedure time for the LT insertion. Prospective, randomized controlled trials are needed.

Abbreviations: CT = computed tomography, LT = long intestinal tube, NEWSt = nonendoscopic over-the-wire method via short nasogastric tube, NGT = short nasogastric tube, SBO = small bowel obstruction, SD = standard deviation.

Keywords: long intestinal tube, NEWSt, short nasogastric tube, small bowel obstruction

1. Introduction
Gastrointestinal decompression is the most effective therapy for the patients with acute small bowel obstruction (SBO) without any indications of strangulation.[1–4] There are 2 ways of bowel decompression, with insertion of a short nasogastric tube (NGT) or of a long intestinal tube (LT). NGT is easier to insert than LT, but it is less effective for suctioning the distal intestine. A randomized trial indicated that there was no advantage of decompression by LT compared with such treatment by NGT[5]; however, in that study, the placement of LT beyond the duodenjejunal flexure was not confirmed using fluoroscopy.

In addition, there have been reports from many countries describing the usefulness of LT decompression for the management of SBO.[1–4,6–8] Therefore, if the clinical course after NGT insertion is not satisfactory, we have to consider inserting the LT instead.

When exchanging an NGT to an LT, the NGT is usually completely withdrawn at first, followed by reinserterion of the LT. However, LT insertion is often a difficult and time-consuming procedure and causes severe patient distress. Currently, transnasal ultrathin endoscopy-assisted LT insertion has been established.[9–17] Several studies have revealed that endoscopic insertion is superior to conventional fluoroscopic insertion in terms of the success rate of LT placement beyond the duodenjejunal flexure and the time required for the procedure.[18–19] However, endoscopic insertion always requires a thin-caliber endoscope and an endoscopist. Therefore, the procedure cannot be performed at all hospitals. Moreover, aspiration pneumonia may sometimes occur after endoscopic insertion.

Therefore, we developed a novel technique called nonendoscopic over-the-wire method via short nasogastric tube (NEWSt) for easy and safe LT insertion without endoscopy. In this study, we assessed the usefulness and safety of NEWSt for patients with SBO.
2. Methods

2.1. Patients

In all, 35 consecutive patients who underwent LT insertion for SBO without any indications of strangulation at the JR Tokyo General Hospital between November 2011 and February 2015 were included in this retrospective study. Computed tomography (CT) scan of abdomen and pelvis was performed in all the patients on admission to aid the diagnosis, etiology, and severity of SBO. Generalized peritonitis on physical examination or other evidence of clinical deterioration such as fever, leukocytosis, tachycardia, metabolic acidosis, massive ascites, and continuous pain were considered as the indication of strangulation. Patients with any of the following characteristics were excluded: prior total gastrectomy, and/or existence of obstructive tumor. Patients were assigned to either of the following groups based on the method of LT insertion: NEWSt or transnasal ultrathin endoscopy-assisted.

2.2. Instruments and procedures

All procedures were performed in the x-ray suite of our hospital. The method of LT insertion was determined by the attending physician of each patient.

2.2.1. NEWSt. For local anesthesia, 8% lidocaine was sprayed in the pharynx and a small amount of 2% lidocaine jelly was applied to the nostrils. A 1.32-mm wide, 500-cm long Dennis guidewire (Covidien, Tokyo, Japan) was inserted via NGT as distally as possible beyond the duodenojejunal flexure under fluoroscopy guidance. (C) The NGT is withdrawn while the guidewire is kept in place. (D) A hydrophilic long tube (16 Fr, 300 cm; Argyle Super Dennis Tube; Covidien, Tokyo, Japan) is inserted along the guidewire. (E) The guidewire is withdrawn. LT = long intestinal tube.

Figure 1. Procedure of LT insertion using nonendoscopic over-the-wire method via short nasogastric tube (NEWSt). (A) A short nasogastric tube (NGT) is placed in the stomach before NEWSt. (B) A Dennis guidewire (1.32 mm, 500 cm long; Covidien, Tokyo, Japan) is inserted via NGT as distally as possible beyond the duodenojejunal flexure under fluoroscopy guidance. (C) The NGT is withdrawn while the guidewire is kept in place. (D) A hydrophilic long tube (16 Fr, 300 cm; Argyle Super Dennis Tube; Covidien, Tokyo, Japan) is inserted along the guidewire. (E) The guidewire is withdrawn. LT = long intestinal tube.

Figure 2. Radiographs of NEWSt. (A) A short nasogastric tube (NGT) is placed in the stomach. (B) A Dennis guidewire (1.32 mm, 500 cm long; Covidien, Tokyo, Japan) is inserted via NGT. (C) The guidewire is advanced beyond the duodenojejunal flexure. (D) After NGT is withdrawn, a hydrophilic long tube (16 Fr, 300 cm; Argyle Super Dennis Tube; Covidien, Tokyo, Japan) is inserted along the guidewire, which is withdrawn. NEWSt = nonendoscopic over-the-wire method via short nasogastric tube.
2.2.2. Endoscopy-assisted. For local anesthesia, application of a drop of naphazoline nitrate and 4% lidocaine spray on the nostrils were performed. A thin-caliber endoscope (GF-XP260N; Olympus, Tokyo, Japan) was transnasally inserted with the patient in the semiprone position. The scope was advanced to the duodenum. The guidewire was inserted via the working channel of the endoscope into the small bowel and beyond the duodenoejejunal flexure under fluoroscopy guidance. The endoscope was then withdrawn while the guidewire was kept in place. Afterward, the tube was indwelled in a similar way as described in NEWSt.

2.3. Baseline characteristics

Data including age, sex, body mass index, and previous abdominal surgery were obtained from the medical records.

2.4. Study endpoints

The primary outcomes of interest were success rate and procedure time, and the secondary outcomes were the clinical outcomes including surgery rate, fasting period, hospital stay, and recurrence rate, and complications. Successful intubation was defined as LT insertion beyond the duodenoejejunal flexure. Procedure time was determined from guidewire insertion in NEWSt group and from endoscope insertion in the endoscopy group. Surgery rate was the percentage of patients who needed surgery for SBO treatment, and recurrence rate was that of patients who had SBO relapse after withdrawal of the LT. Fasting period was calculated as the interval between admission and resumption of oral intake.

A diagnosis of aspiration pneumonia as a complication required the presence of new radiographic infiltrates, an aspiration event during LT insertion, and at least 1 of the following: symptoms of infection, such as fever (≥38.0°C), productive cough, purulent sputum from the lower respiratory tract, or chest pain; or white blood cell count >10,000/μL and/or elevated C-reactive protein >0.03mg/dL. The I-ROAD classification of the revised Japanese Respiratory Society guidelines on healthcare-associated pneumonia[11] was used for evaluating the severity of pneumonia.

2.5. Statistical analyses

All statistical analyses were conducted using the R program version 3.1.2 (R Development Core Team 2014, The R Foundation for Statistical Computing; Vienna, Austria). Continuous variables were reported as mean ± standard deviation (SD), and categorical variables were reported as frequency and percentage. Welch t test was used for group comparisons of continuous variables. Fisher exact test was used for group comparisons of categorical variables. P values of <0.05 were considered as statistically significant.

2.6. Ethics

This study was conducted in accordance with the Declaration of Helsinki and the ethical guidelines for epidemiological research developed by the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Health, Labor and Welfare, Japan. Written informed consents were obtained from all the patients or their relatives before performing LT insertion. The study design was approved by the ethics committee of the author’s institution (registration no. H27–16).

### Table 1

| Characteristics | NEWSt (n=16) | Endoscopy-assisted (n=17) | P |
|-----------------|-------------|---------------------------|---|
| Age, y          | 70±20       | 70±15                     | 0.971 |
| Male, n (%)     | 7 (44)      | 9 (53)                    | 0.732 |
| BMI, kg/m²      | 21.5±4.1    | 21.1±2.7                  | 0.742 |
| Previous abdominal surgery, n (%) | 11 (69) | 15 (88) | 0.224 |
| Surgical site, n (%) |         |                           |     |
| Stomach         | 0 (0)       | 3 (18)*                   | 0.227 |
| Small intestine | 0 (0)       | 2 (12)                    | 0.485 |
| Colon           | 4 (25)      | 6 (35)                    | 0.708 |
| Liver, gallblader, pancreas | 1 (6) | 2 (12) | 1 |
| Uterus, ovary   | 7 (44)      | 8 (47)                    | 1 |
| Others          | 3 (19)      | 1 (6)                     | 0.103 |

*Values are presented as mean±SD, unless otherwise stated.
† All 3 patients had a history of partial gastrectomy with Billroth-I method.

3. Results

3.1. Patients

In all, 33 patients met the inclusion criteria: 16 underwent NEWSt and 17 underwent the endoscopy-assisted method (Fig. 3). The 2 patients who were excluded from this study due to the obstructive tumor were of pancreas cancer and cecum cancer. Both the tumors were massive enough to be detected by CT scanning on admission. Additionally, these were confirmed by autopsy and surgery, respectively. NEWSt was performed within 24 hours after NGT insertion in 13 patients (81%). The 2 groups were similar in baseline characteristics (Table 1). In the endoscopy group, 3 patients had a history of partial gastrectomy with Billroth-I method.

3.2. Success rate and procedure time

Success rate was 100% in both groups (P=1.0). The procedure time was numerically, but not statistically, shorter in the NEWSt group compared with the endoscopy group (24±13 vs 30±13 min; P=0.174) (Table 2).

3.3. Clinical outcome and complications

There were no statistically significant differences between the 2 groups in terms of surgery rate (31% vs 12%; P=0.225), fasting...
Table 2
Comparison of procedures for LT insertion for SBO.

| Parameters               | NEWSt (n = 16) | Endoscopy-assisted (n = 17) | P    |
|--------------------------|----------------|-----------------------------|------|
| Success rate, n (%)      | 16 (100)       | 17 (100)                    | 1    |
| Procedure time, min      | 24±13          | 30±13                       | 0.174|

LT = long intestinal tube, NEWSt = nonendoscopic over-the-wire method via short nasogastric tube, SBO = small bowel obstruction.

Table 4
Adverse events in patients who underwent LT insertion for SBO.

| Events                       | NEWSt (n = 16) | Endoscopy-assisted (n = 17) | P    |
|------------------------------|----------------|-----------------------------|------|
| Epistaxis, n (%)             | 1 (0)          | 0 (0)                       | 0.485|
| GI perforation, n (%)        | 0 (0)          | 0 (0)                       | 1    |
| GI bleeding, n (%)           | 0 (0)          | 0 (0)                       | 1    |
| Aspiration pneumonia, n (%)  | 0 (0)          | 2 (12)                      | 0.485|

GI = gastrointestinal, LT = long intestinal tube, NEWSt = nonendoscopic over-the-wire method via short nasogastric tube, SBO = small bowel obstruction.

Table 3
Clinical outcomes of patients who underwent LT insertion for SBO.

| Parameters         | NEWSt (n = 16) | Endoscopy-assisted (n = 17) | P    |
|--------------------|----------------|-----------------------------|------|
| Surgery, n (%)     | 5 (31)         | 2 (12)                      | 0.225|
| Fasting period, d  | 11.3±6.3       | 9.9±4.5                     | 0.482|
| Hospital stay, d   | 26.4±22.1      | 18.7±7.0                    | 0.194|
| Recurrence, n (%)  | 3 (19)         | 4 (24)                      | 1    |

LT = long intestinal tube, NEWSt = nonendoscopic over-the-wire method via short nasogastric tube, SBO = small bowel obstruction.

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