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**Original Article**

# Original Article

# Routine nasogastric tube placement in patients with small esophageal perforation after endoscopic foreign body removal may be unnecessary: a propensity score matching analysis

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## Abstract

**Background:** Nasogastric tube (NGT) placement is part of the post-operative management of upper gastrointestinal perforation, but its routine use in esophageal perforation (EP) caused by foreign bodies remains unclear. The purpose of this research was to investigate the necessity for routine NGT placement in patients with EP after endoscopic foreign body removal.

**Methods:** A total of 323 patients diagnosed with EP caused by foreign bodies at the First Affiliated Hospital of Nanchang University between January 2012 and December 2021 were included in this retrospective study. Patients were divided into the NGT group and the non-NGT group according to whether or not NGT placement was performed. The perforation healing rate, post-operative adverse events, hospital stay, and death rate were analysed using a 1:1 propensity score matching model.

**Results:** Before matching, there were 263 patients in the NGT group and 60 patients in the non-NGT group. There were significant differences in the time to treatment, infection, albumin, and types of endoscopy between the two groups, while the length of hospital stay in the NGT group was significantly longer than that in the non-NGT group. After 1:1 propensity score matching, 48 pairs of patients were matched between the two groups. The perforation healing rate, post-operative adverse events, length of hospital stay, and death rate did not show significant differences between the two groups.

**Conclusions:** For patients with small EP caused by foreign bodies, routine NGT placement after endoscopic foreign body removal may be unnecessary.

**Keywords:** esophageal perforation; foreign body; nasogastric tube placement; propensity score matching

## Introduction

Esophageal perforation (EP) is one of the most common esophageal emergencies [1] and is often complicated by serious adverse events when it is not diagnosed and treated in time, causing great distress to clinicians [2]. In our actual clinical work, the treatment of EP mainly includes conservative, endoscopic, and surgical treatment [3, 4]. Foreign bodies often lead to EP and non-operative treatment has been proved to be an effective therapy for EP caused by foreign bodies [5]. After endoscopic foreign body removal, post-operative management also plays a crucial role in the prognosis of patients.

Nasogastric tube (NGT) placement is routine post-operative management for many abdominal procedures, as it is believed to relieve abdominal distension and vomiting through gastrointestinal decompression [6]. A review pointed out that endoscopic full-thickness resection naturally leads to gastrointestinal perforation and therefore routine NGT placement is required for post-operative gastrointestinal decompression [7]. Nevertheless, NGT placement inevitably causes nasopharyngeal discomfort, which also needs to be paid attention to in practical clinical work. Several studies have investigated the need for NGT placement after abdominal surgery and they have found that NGT placement does not reduce the incidence of adverse events [8, 9]. Sekioka *et al.* [10] conducted a retrospective analysis on 62 patients with acute appendicitis perforation; the study showed that the mean time to first oral intake and post-operative length of stay were significantly lower in the non-NGT group than in the NGT group, and thus it was concluded that the routine placement of NGTs is not always necessary. A Spanish

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study involving 43 patients undergoing esophagectomy concluded that not using NGTs was a safe measure and improved patient comfort and post-operative recovery [11], whereas no studies have investigated the routine use of NGTs in EP caused by foreign bodies. Hence, we designed this study to investigate the necessity for routine NGT placement in patients with EP after endoscopic foreign body removal so as to provide a reference for clinical application.

## Materials and methods

### Patients and data collection

A retrospective analysis included patients with EP caused by foreign bodies at the First Affiliated Hospital of Nanchang University (Nanchang, China) between January 2012 and December 2021. The exclusion criteria were as follows: (i) patient did not receive treatment after the diagnosis; (ii) failure to remove foreign body under endoscopy; and (iii) incomplete demographic data. The following data were collected: gender, age, underlying diseases (diabetes, hypertension, cardio-cerebrovascular diseases, psychogenia), types of foreign body, time to treatment, location of perforation, whether NGT placement was performed, infection status, serum albumin, white blood cell count, types of endoscopy, perforation healing rate, post-operative adverse events (fever, pneumonia, pleural effusion, multisystem organ failure), hospitalization, and death rate. The reporting of this research conforms to the STROBE statement [12]. This research study was conducted retrospectively from data obtained for clinical purposes. The Ethics Committee of the First Affiliated Hospital of Nanchang University approved this study and granted a waiver to obtain written informed consent due to the design of the retrospective study.

### Relevant definitions

EP was defined as the presence of a foreign body penetrating the esophageal wall or the presence of free gas around the esophagus or in the mediastinum on computed tomography (CT). We divided the types of foreign body into fish bones and others, and other types of foreign body mainly included animal bones, jujube pit, false tooth, and so on. Time to treatment refers to the time interval between the ingestion of a foreign body and the receipt of treatment. When pyogenic esophagitis was found on endoscopy or when mediastinal abscess and mediastinal inflammation were seen on CT, we defined the patient as having a perforation with infection. Antibiotic therapy and proton-pump inhibitors were routinely administered and all included patients underwent endoscopic foreign body removal successfully. After endoscopic foreign body removal, NGT placement was decided according to the preference of the endoscopist.

### Statistical analysis

Continuous variables are described as the mean ± standard deviation or median (interquartile range) and t-tests or nonparametric tests were performed. The categorical variables are expressed as relative numbers (percentage or constituent ratio) and the chi-square test or Fisher's exact test were used. We divided these patients into the NGT group and non-NGT group according to whether a NGT was performed. To control and reduce the effects of potential confounding factors, a propensity score matching (PSM) analysis was applied. We included as many variables as possible in the propensity score model in an effort to maximally inform the propensity of the dependent variable. The included variables are as follows: age, sex, diabetes, hypertension, cardio-cerebrovascular diseases, psychogenia, types of foreign body, time to treatment, location of perforation, infection status, serum albumin, white blood cell count, and types of endoscopy. Patients were matched in a 1:1 ratio using the nearest-neighbor method (caliper width = 0.1). After matching, scatter diagram and histogram of the tendency distribution were plotted to assess the matching effect. All the statistical tests were two-sided and $P < 0.05$ was considered significant. Statistical analysis was performed using R 4.1.1 statistical software (R Foundation for Statistical Computing, Vienna, Austria).

## Results

### Baseline characteristics of patients before matching

From January 2012 to December 2021, 352 patients in our hospital were diagnosed with EP caused by a foreign body and 323 patients were ultimately included in this study (Figure 1). Table 1 shows the baseline characteristics of these patients. In total, there were 263 patients in the NGT group and 60 patients in the non-NGT group. More than half of the patients in both groups were female (56.3% vs 61.7%). Fish bones were the most common type of foreign body and the most common perforation location was the cervical esophageal, followed by the thoracic esophageal. The time from perforation to treatment was >24 h in 164 patients in the NGT group and 24 patients in the non-NGT group (62.4% vs 40.0%, $P = 0.003$). The infection rate in the NGT group was 50.6%, which was significantly higher than that in the non-NGT group (31.7%). The average albumin of the non-NGT group was 44.1 ± 5.0 g/L compared with 42.7 ± 4.5 g/L in the NGT group ($P = 0.043$). In terms of endoscopy type, esophagoscopy was more commonly used in the NGT group whereas gastroscopy was more frequently used in the non-NGT group ($P < 0.001$). There was no significant difference in underlying diseases (diabetes, hypertension, liver cirrhosis, cardio-cerebrovascular diseases, and psychogenia) between the two groups.

### Outcomes in the NGT group and the non-NGT group before matching

The outcomes of patients who underwent NGT and non-NGT placement after endoscopic foreign body removal are shown in Table 2. The perforation healing rate of the non-NGT group was 98.3%, which was similar to 97.7% of the NGT group, and the difference was not statistically significant. Fever was the most common post-operative adverse event, occurring in 43 patients in the NGT group and 7 in the non-NGT group. Pleural effusion occurred in 16 patients in the NGT group and none in the non-NGT group, showing a critical difference ($P = 0.050$). The median length of hospital stay was 5 (3–7) days in the NGT group, which was significantly longer than that in the non-NGT group (3 [2–5]; $P < 0.001$). Three patients died of multisystem organ failure in the NGT group and none in the non-NGT group.

### Outcomes in the NGT group and the non-NGT group after matching

In the total cohort, there were significant differences in the time to treatment, infection, albumin, and types of endoscopy between the two groups. After 1:1 PSM using the nearest-neighbor method, 48 pairs of patients were matched between the NGT and non-NGT groups, and there was no significant difference in the baseline characteristics between the two groups (Table 1). A scatter diagram (Figure 2) and a histogram (Figure 3) of the tendency distribution were plotted to assess the matching effect. In the matched cohort, fever occurred in seven patients (14.6%) in the

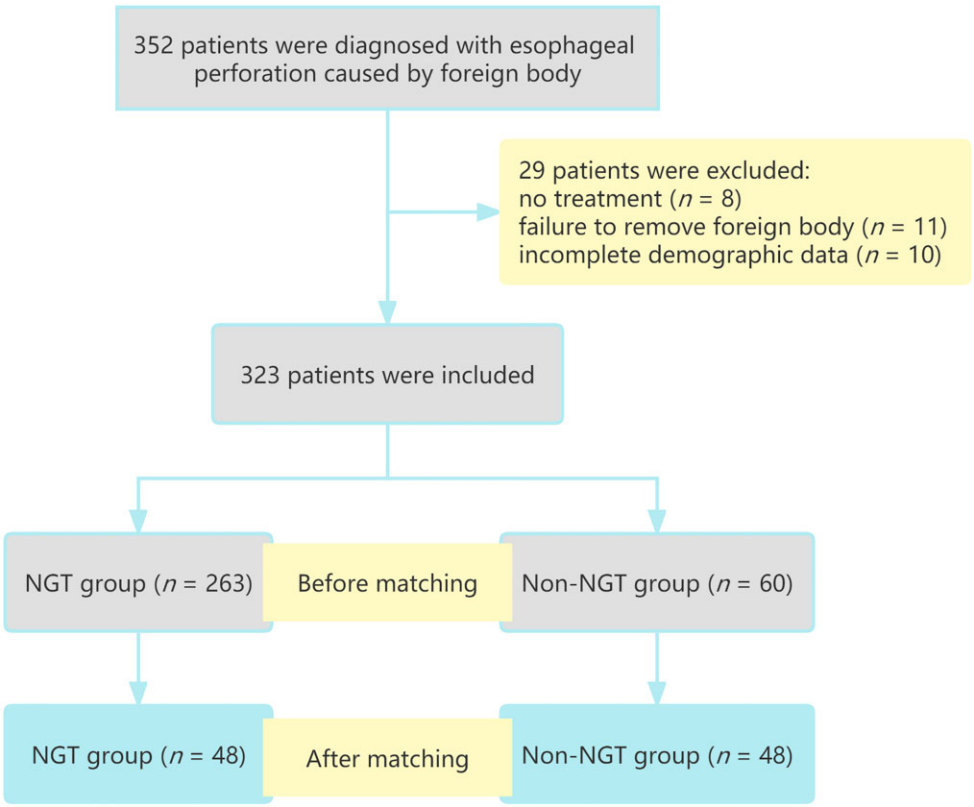


**Figure 1.** Flow chart of patients enrolled in the study. NGT, nasogastric tube.

**Table 1.** Baseline characteristics of patients before and after propensity score matching

| Variable | Before PSM | | | After PSM | | |
|---|---|---|---|---|---|---|
| | NGT group (*n* = 263) | Non-NGT group (*n* = 60) | *P*-value | NGT group (*n* = 48) | Non-NGT group (*n* = 48) | *P*-value |
| Age, years, mean ± SD | 56.6 ± 16.9 | 51.9 ± 19.0 | 0.055 | 47.6 ± 16.7 | 48.6 ± 19.4 | 0.787 |
| Gender, *n* (%) | | | 0.537 | | | 0.527 |
| Male | 115 (43.7) | 23 (38.3) | | 16 (33.3) | 20 (41.7) | |
| Female | 148 (56.3) | 37 (61.7) | | 32 (66.7) | 28 (58.3) | |
| Underlying diseases, *n* (%) | | | | | | |
| Diabetes | 12 (4.6) | 1 (1.7) | 0.303 | 1 (2.1) | 1 (2.1) | 1.000 |
| Hypertension | 49 (18.6) | 11 (18.3) | 1.000 | 8 (16.7) | 7 (14.6) | 1.000 |
| Cardio-cerebrovascular diseases | 10 (3.8) | 2 (3.4) | 0.862 | 0 (0) | 0 (0) | 1.000 |
| Psychogenia | 5 (1.9) | 1 (1.7) | 0.903 | 1 (2.1) | 1 (2.1) | 1.000 |
| Types of foreign body, *n* (%) | | | 1.000 | | | 0.683 |
| Fish bone | 157 (59.7) | 36 (60.0) | | 24 (50.0) | 27 (56.2) | |
| Others | 106 (40.3) | 24 (40.0) | | 24 (50.0) | 21 (43.8) | |
| Time to treatment, *n* (%) | | | 0.003 | | | 0.836 |
| ≤24 h | 99 (37.6) | 36 (60.0) | | 29 (60.4) | 27 (56.2) | |
| >24 h | 164 (62.4) | 24 (40.0) | | 19 (39.6) | 21 (43.8) | |
| Location of perforation, *n* (%) | | | 0.913 | | | 0.385 |
| Cervical | 164 (62.4) | 37 (61.7) | | 28 (58.3) | 31 (64.6) | |
| Thoracic | 89 (33.8) | 20 (33.3) | | 19 (39.6) | 14 (29.1) | |
| Abdominal | 10 (3.8) | 3 (5.0) | | 1 (2.1) | 3 (6.3) | |
| Infection, *n* (%) | 133 (50.6) | 19 (31.7) | 0.012 | 17 (35.4) | 19 (39.6) | 0.833 |
| WBC, $\times 10^9$/L, mean ± SD | 9.8 ± 3.6 | 9.6 ± 3.2 | 0.583 | 10.0 ± 3.3 | 9.8 ± 3.5 | 0.694 |
| Albumin, g/L, mean ± SD | 42.7 ± 4.5 | 44.1 ± 5.0 | 0.043 | 44.8 ± 4.3 | 43.7 ± 5.2 | 0.275 |
| Types of endoscopy, *n* (%) | | | <0.001 | | | 0.772 |
| Esophagoscopy | 150 (57.0) | 6 (10.0) | | 8 (16.7) | 6 (12.5) | |
| Gastroscopy | 113 (43.0) | 54 (90.0) | | 40 (83.3) | 42 (87.5) | |

PSM, propensity score matching; SD, standard deviation; NGT, nasogastric tube; WBC, white blood cell.

NGT group, which was still slightly higher than in the non-NGT group (8.3%), whereas there were no significant differences in the perforation healing rate and mortality rate between the two groups. The median length of hospital stay in the NGT group was 4 (3–6) days, which showed no statistical difference compared with 3 (2–5) days in the non-NGT group (Table 3).

## Discussion

EP is a complex disease that is often fatal if not diagnosed in time [13]. A large number of studies have shown that timely diagnosis and treatment of EP can improve the prognosis of patients [14–16]. At the same time, the development of a reasonable post-operative management plan after endoscopic foreign body removal is also crucial for the treatment of patients. More and more scholars are skeptical about the efficacy of NGT insertion after abdominal surgery [11, 17]. There is a lack of data on the necessity for NGT placement in EP caused by a foreign body. Therefore, we retrospectively analysed the data of patients with EP who successfully underwent endoscopic foreign body removal in our hospital. Due to the critical nature of EP, most of the current studies are retrospective, so we used the PSM method to eliminate confounding factors as much as possible.

In this research, a total of 323 patients were included, and there were 263 in the NGT group and 60 in the non-NGT group. In general, fish bones are the most common type of foreign body. They have sharp edges and are prone to causing perforation. Before matching, >80% of patients with a time to treatment of >24 h received NGT placement. Almost all patients treated with esophagoscopy underwent NGT placement, which was significantly more than those treated with gastroscopy. One of the reasons for this situation may be the personal habits of different endoscopists. Therefore, we also included this potential confounder in the propensity score model. On the clinical outcome measures, we found that more patients in the NGT group had post-operative pleural effusion compared with the non-NGT group. In addition, a significantly longer length of hospital stay in the NGT group than in the non-NGT group was also shown. To reduce the inevitable selection bias and confounding factors in a retrospective study, we used the PSM method to balance the baseline characteristics of the two groups. After matching, the perforation healing rate of the NGT group was similar to that of the non-NGT group. This may be due to the fact that the EP caused by foreign bodies is usually small, so a good perforation healing rate can be achieved without placing a NGT after endoscopic foreign body removal. Regarding post-operative complications, the incidence of post-operative fever in the NGT group was relatively higher than that in the non-NGT group before and after matching, although there was no statistically significant difference. A previous study by our team also found that NGT placement after endoscopic operation may increase the incidence of fever [18]. Therefore, minimizing the use of NGTs may be helpful for post-operative management. There seemed to be a tendency for shorter hospital stays in the non-NGT group than in the NGT group, suggesting that NGT placement may not help to shorten the duration of the disease. A previous meta-analysis also showed that prophylactic nasogastric decompression after abdominal surgery may lead to longer hospital stays [19].

There were several limitations to our study. On the one hand, the retrospective design may have biased the accuracy of the results, although PSM methods were used. On the other, as this study is single-center research with a relatively small sample size, it still needs to be further tested by using a multicenter large-sample study.

**Table 2.** Outcomes in the NGT group and the non-NGT group before matching

| Variable | NGT group ($n = 263$) | Non-NGT group ($n = 60$) | *P*-value |
|---|---|---|---|
| Perforation healing, *n* (%) | 257 (97.7) | 59 (98.3) | 0.768 |
| Post-operative adverse events, *n* (%) | | | |
| Fever | 43 (16.3) | 7 (11.7) | 0.480 |
| Pneumonia | 6 (2.3) | 1 (1.7) | 0.768 |
| Pleural effusion | 16 (6.1) | 0 (0) | 0.050 |
| Multisystem organ failure | 4 (1.5) | 0 (0) | 0.336 |
| Hospitalization, days, median (IQR) | 5 (3–7) | 3 (2–5) | <0.001 |
| Death rate, *n* (%) | 3 (1.1) | 0 (0) | 0.406 |

NGT, nasogastric tube; IQR, interquartile range.

## Conclusion

For patients with small EP caused by foreign bodies, routine nasogastric tube placement after endoscopic foreign body removal may be unnecessary.

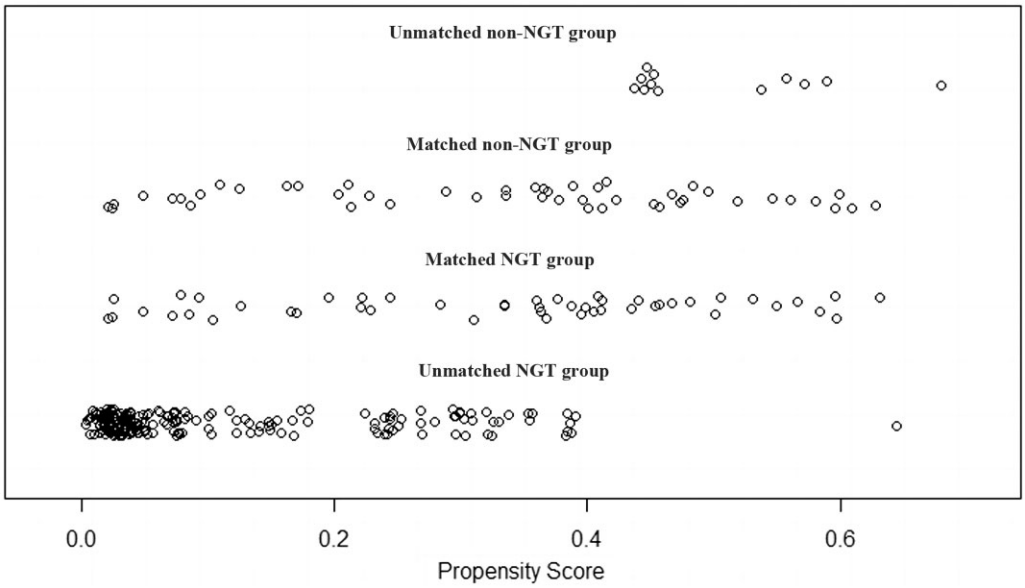


**Figure 2.** Scatter plot of the tendency distribution before and after propensity score matching. NGT, nasogastric tube.

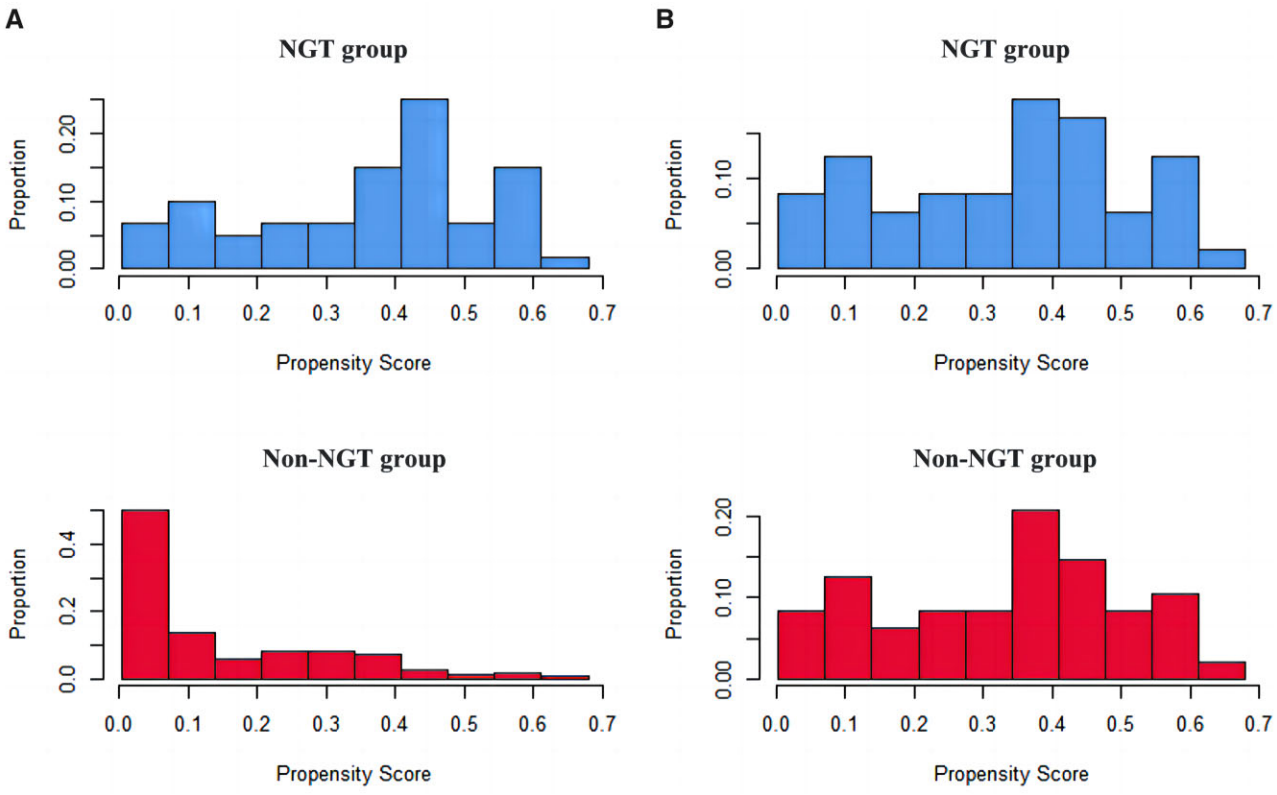


**Figure 3.** Histogram of the tendency distribution before and after propensity score matching. (A) Before PSM. (B) After PSM. NGT, nasogastric tube; PSM, propensity score matching.

**Table 3.** Outcomes in the NGT group and the non-NGT group after matching

| Variable | NGT group ($n = 48$) | Non-NGT group ($n = 48$) | *P*-value |
|---|---|---|---|
| Perforation healing, *n* (%) | 47 (97.9) | 47 (97.9) | 1.000 |
| Post-operative adverse events, *n* (%) | | | |
| Fever | 7 (14.6) | 4 (8.3) | 0.522 |
| Pneumonia | 1 (2.1) | 0 (0) | 0.315 |
| Pleural effusion | 1 (2.1) | 0 (0) | 0.315 |
| Multisystem organ failure | 0 (0) | 0 (0) | 1.000 |
| Hospitalization, days, median (IQR) | 4 (3–6) | 3 (2–5) | 0.375 |
| Death rate, *n* (%) | 0 (0) | 0 (0) | 1.000 |

NGT, nasogastric tube; IQR, interquartile range.

## Authors' Contributions

F.L. collected data, analysed relevant information, and drafted the manuscript; Q.Y. and Z. Zhan collected data and drafted the manuscript; Z. Zhu, X.P., C.W., B.L., Y.Z., and Y.C. clinically managed the patients. X.S. designed the study and clinically managed the patients. All authors have read and approved the final version of the manuscript.

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## Conflict of Interest

The authors declare that there is no conflict of interest.

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