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ORIGINAL RESEARCH

Different gastric tube placement techniques in intubated adults: a randomized trial

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Abstract

Background: The reverse Sellick maneuver helps to widen the esophagus by moving the cricoid cartilage forward, which makes it easier to insert the nasogastric tube smoothly. This study aimed to evaluate the effectiveness of the reverse Sellick maneuver for nasogastric tube placement in patients with tracheal intubation. **Methods**: This trial enrolled 66 patients who were intubated and admitted to the intensive care unit of a tertiary hospital in China between July 2022 and December 2023. The experimental group underwent nasogastric tube insertion using the reverse Sellick maneuver, while the control group received the traditional insertion technique. The success rates of tube placement, the durations of the procedures, and the incidence of adverse events were compared between the two groups. **Results**: The reverse Sellick maneuver demonstrated a success rate of 96.9% compared to 93.9% in the traditional technique (p = 1.000). Mean placement times were 9 minutes in the experimental group and 7 minutes in the control group (p = 0.892). The maximum number of placement attempts was three in the experimental group and four in the control group ($p < 0.001$). Accidental tracheal entry occurred in one case in the experimental group versus four cases in the control group. We found a reduction in nasogastric tube twisting or knotting with the reverse Sellick maneuver ($p < 0.05$) and no differences in nasal bleeding and accidental tracheal entry ($p > 0.05$). **Conclusions**: The reverse Sellick maneuver provides a comparable success rate to the traditional technique for nasogastric tube placement in intubated patients, with a potential reduction in serious adverse events. **Clinical Trial Registration**: The clinical trial registration was completed with the registration number: ChiCTR2200063982.

Keywords

Reverse Sellick maneuver; Nasogastric tube placement; Tracheal intubation; Intensive care unit

1. Introduction

Nasogastric feeding provides patients with the necessary food, nutrients, water and medicine. It is one of the most important methods of providing or supplementing nutrition in clinical practice, especially for critically ill patients who are intubated [1]. Nasogastric tube insertion is an essential nursing skill, and the quality of insertion directly affects patients. Thus, clinical nurses need to ensure the safety of nasogastric tube insertion [2]. Furthermore, it is an invasive procedure. The traditional insertion technique involves blind insertion of the catheter into the stomach through the nasal cavity without the assistance of instruments. This often requires repeated attempts and can lead to adverse events such as bleeding from nasal mucosal damage, twisting, knotting, and even serious adverse events such as accidental insertion into the trachea and esophageal mucosal tears [3, 4]. In intubated patients, the esophageal lumen becomes narrowed due to compression caused by the endotracheal tube placement. Additionally, the absence of spontaneous swallowing reflexes, caused by factors such as sedation, further complicates nasogastric tube placement [5, 6]. There is an increased risk of accidentally inserting the tube into the lungs when a nasogastric tube is placed in an intubated patient [7]. The success rate for placing nasogastric tubes using traditional methods ranges from 40–58%, with a failure rate of up to 50% for the first insertion attempt [8]. The incidence of adverse events, such as nasal mucosal injury, bleeding and accidental insertion into the trachea, also increases.

Alternative techniques, such as the reverse Sellick maneuver [9], lateral neck pressure flexion technique [10], ultrasound-guided catheter placement [11, 12], use of cryo-NGT [13] and GlideScope™ visualization technology have been studied [14, 15]. The reverse Sellick maneuver expands the esophageal passage by lifting the cricoid cartilage forward, facilitating smooth insertion of the nasogastric tube. Studies have shown that the reverse Sellick maneuver achieves a 95% success rate within the first and second attempts. It also requires less time, is simple and convenient to perform, and is associated with

reduced adverse events [6].

Despite these advantages, the traditional technique remains widely used in clinical practice for critically ill intubated patients. In this study, we investigated the use of the reverse Sellick maneuver for nasogastric tube placement, aiming to improve the intubation success rate and reduce adverse events. Additionally, we assessed its applicability to critically ill, intubated patients.

2. Design and methods

2.1 Study design and setting

This randomized controlled trial was conducted in the emergency intensive care unit of a tertiary hospital in Chengdu, China, from July 2022 to December 2023. The care unit has 16 beds and admits approximately 50 patients per month. This study adhered to the Consolidated Standards of Reporting Trials (CONSORT) criteria.

2.2 Study population

The inclusion criteria were the following: critically ill patients aged >18 years who had undergone tracheal intubation, and the need for a nasogastric tube had been previously established by a physician.

Patients with contraindications to nasogastric tube placement, such as esophageal stenosis, skull base or facial fracture, nasopharyngeal cancer or acute inflammation, esophageal varices, bleeding tendencies, or recent surgery in the nasal cavity were excluded.

A pre-established success rate for nasogastric tube placement was used as the primary evaluation indicator to determine the sample size. Based on a significance level of 0.05, a power of 80%, and previously reported success rates of the traditional nasogastric tube placement versus reverse Sellick maneuver (70% *vs.* 95%), the required sample size for each group was calculated to be 33 cases. Therefore, 66 cases were included in the study.

Patients were randomly assigned to the control and experimental groups using a random number table. The traditional nasogastric tube placement method was used in the control group, while the reverse Sellick maneuver was applied in the experimental group.

2.3 Treatments

2.3.1 Operator training

The procedure was completed by a nurse with ≥6 years of experience and who was in charge of the care unit to minimize operator skill bias. The nurses were trained, and their skill levels in performing the reverse Sellick maneuver were assessed before the study was initiated.

A disposable gastric tube (Xinda) with a specification of 5.33 mm (F16) was selected.

2.3.2 Nasogastric tube placement

(1) Measurement of insertion length: The required insertion length was predetermined by measuring the distance from the tip of the nose to the earlobe and then to the xiphoid process of the sternum.

(2) Nasogastric tube insertion.

Control group. The traditional placement method was used in the control group. The tip of the tube was lubricated with paraffin oil using a cotton ball. The tube was inserted into the selected nostril, first angled slightly upward, and then parallel, and gently inserted backward and downward. When the tube was inserted approximately 14–16 cm into the throat area, the left hand was used to hold the patient's head so the lower jaw touched the sternal manubrium. The tube was then slowly inserted to the predetermined length using the right hand.

Experimental group. The reverse Sellick maneuver was used in the experimental group. The anterior end of the nasogastric tube was lubricated with paraffin oil using a cotton ball. The tube was inserted similarly through the selected nostril, first slightly upward and then parallel, and gently downward. When resistance was felt at around 14–16 cm, insertion was paused. The left hand was used to pinch the tracheal ring from the lower edge of the tracheal cricoid cartilage (at the level of the esophageal neck), allowing the tube to be gently pulled upward to widen the esophageal passage. Simultaneously, the right hand quickly advanced the nasogastric tube by 10 cm. The left hand was then released, and the tube continued to be inserted to the predetermined length.

2.3.3 Extraction of gastric aspirate and auscultation to confirm tube placement

(1) Gastric aspirate extraction: A 20 mL empty needle was used to extract the gastric content from the end of the nasogastric tube. A volume of aspirate >10 mL indicated successful stomach placement.

(2) Auscultation method: A stethoscope was placed over the patient's stomach, while 10 mL of air was quickly injected into the stomach through the nasogastric tube. The sound of air passing through the liquid was detected using the stethoscope.

After confirming that the nasogastric tube had been successfully placed in the stomach, it was fixed to the cheek with tape.

2.4 Observational indicators and data collection methods

General patient data such as sex, age, Glasgow coma scale (GCS), blood pressure, respiration, blood oxygen saturation (SPO_2) and sequential organ failure score were collected.

The observational indicators in this study were as follows. (1) Success rate of tube placement: Placement in two attempts was considered successful. If both attempts were unsuccessful, the procedure was considered a "process failure". Success rate = number of successful placements/total number of placements. (2) Duration for successful tube placement: The time from tube insertion to the successful placement of the tube, inclusive of the time required for the first and second attempts, was calculated in seconds using a timer. (3) Successful insertion attempts: The number of attempts to insert a nasogastric tube successfully. (4) Adverse events: This included twisting of the nasogastric tube during insertion, knotting, bleeding and accidental insertion into the trachea.

Data collection: When a patient met the inclusion criteria and required nasogastric tube placement, and was included

in the study, the attending nurse notified the researcher. The patient's general information and observational indicators were then recorded.

2.5 Statistical analysis

SPSS 26.0 (IBM, Chicago, IL, USA) was used for the statistical analysis of the data. The measurement data were first tested for normality. Normally distributed data were statistically described as median (Q_{25}, Q_{75}). Categorical data were presented as frequency and percentage (n (%)). The intergroup analysis was performed using the independent sample *t*-test for continuous variables or chi-square test for categorical variables. A *p*-value < 0.05 was considered statistically significant.

3. Results

3.1 General information

Sixty-six intubated patients were included in this study, with an average age of 54.80 $\pm$ 16.50 years, including 38 males. The experimental and control groups each included 33 patients. There were no statistically significant differences in baseline characteristics, such as age, Sequential Organ Failure Assessment (SOFA) score or GCS ($p > 0.05$). Table 1 shows the comparison of baseline data between the two groups.

3.2 Comparison of the success rate, duration and number of attempts

There were no significant differences between the two groups in terms of overall tube placement success rate and placement duration ($p > 0.05$). However, the average duration in the experimental group was longer than in the control group (9 *vs.* 7 minutes). The success rate of the first attempt insertion in the control group was 75.8%, which was significantly higher than the experimental group, *i.e.*, 30.3% ($p < 0.05$). The maximum number of attempts required for successful placement was four in the control group (n = 2) and three in the experimental group (n = 1); this difference was statistically significant ($p < 0.05$) (Table 2).

3.3 Comparison of adverse events

There were four cases of accidental tracheal insertion in the control group and one case in the experimental group. No significant differences were found between the groups in terms of nasal bleeding or accidental tracheal insertion ($p > 0.05$). However, there was a statistically significant difference in the incidence of nasogastric tube twisting or knotting between the two groups ($p < 0.05$) (Table 3).

4. Discussion

There were no significant differences in the overall success rate and duration of tube placement between the reverse Sellick maneuver and the traditional technique ($p > 0.05$) in this study. However, the first-attempt success rate was significantly higher for the traditional technique (75.8%) compared to the reverse Sellick maneuver (30.3%) ($p < 0.05$). The maximum number of attempts required for successful placement was four in the traditional group (n = 2) and three in the experimental group (n = 1) ($p < 0.05$). These findings differ from those of previous studies. Concisely, Mandal *et al.* [16] reported a success rate of 86% for the reverse Sellick maneuver, compared to 56% for the traditional method. Similarly, Monhanchandra *et al.* [13] found the success rate with the reverse Sellick maneuver placement higher than with the traditional method (60% *vs.* 45%). Several factors may explain these discrepancies. First, although nurses were trained in the reverse Sellick maneuver before the study, they may not have been as proficient in this relatively new technique as they were in the traditional technique, due to limited training and application time. Second, this study focused on intubated patients, who pose unique challenges. A common cause of failed nasogastric tube insertion in such patients is compression of the esophagus by the endotracheal tube cuff balloon, particularly around the pyriform sinus and arytenoid cartilage, resulting in esophageal narrowing and increased insertion difficulty [17]. Interestingly, although the traditional technique achieved higher first-attempt success, it also required more attempts overall for successful placement compared to the reverse Sellick maneuver. This may be due to the traditional technique requiring the head of the patient to be elevated to

TABLE 1. Baseline data of the two groups.

Variables	Control Group (n = 33) Median (Q_{25}, Q_{75})	Experimental Group (n = 33) Median (Q_{25}, Q_{75})	*Z*	*p*
Ages (yr)	59.00 (47.00, 72.00)	56.00 (44.50, 62.50)	−1.534	0.125
SOFA score	11.00 (7.00, 12.00)	11.00 (7.00, 12.50)	−0.278	0.781
GCS	4.00 (3.00, 7.00)	5.00 (3.00, 7.00)	−0.020	0.984
Systolic Pressure (mmHg)	113.00 (104.00, 133.50)	120.00 (110.00, 129.00)	−0.905	0.366
Diastolic Pressure (mmHg)	69.00 (61.50, 82.00)	68.00 (58.00, 79.00)	−0.391	0.696
Respiration (times/min)	20.00 (18.00, 23.00)	21.00 (17.50, 24.00)	−0.220	0.826
SPO_2 (%)	95.50 (98.00, 99.00)	96.00 (98.00, 100.00)	−1.517	0.129

GCS: Glasgow coma scale; SPO_2: blood oxygen saturation; SOFA: Sequential Organ Failure Assessment.

TABLE 2. Comparison of the tube placement success rates, durations and number of attempts between the two groups.

Outcomes	Control Group (n = 33)	Experimental Group (n = 33)	Z/χ^2	p
Tube placement success rate for one attempt (n)				
Yes	25 (75.8%)	10 (30.3%)	13.687	<0.001
No	8 (24.2%)	23 (69.7%)		
Tube placement success rate for two attempts (n)				
Yes	31 (93.9%)	32 (96.9%)	0.000	1.000
No	2 (6.1%)	1 (3.1%)		
Duration of successful tube placement (min) Median (Q_{25}, Q_{75})	7.00 (5.00, 20.60)	9.00 (3.50, 11.50)	−0.566	0.892
Number of tube placement attempts (times)				
1	25 (75.8%)	10 (30.3%)	18.366	<0.001
2	6 (18.2%)	22 (66.7%)		
3	0 (0.0%)	1 (3.0%)		
4	2 (6.1%)	0 (0.0%)		

TABLE 3. Comparison of adverse events between the two groups.

Adverse Event	Control Group (n = 33)	Experimental Group (n = 33)	χ^2	p
Nasal bleeding (n)				
Yes	11 (33.3%)	13 (39.4%)	0.262	0.609
No	22 (66.7%)	20 (60.6%)		
Nasogastric tube twisting or knotting (n)				
Yes	7 (21.2%)	16 (48.5%)	5.405	0.020
No	26 (78.8%)	17 (51.5%)		
Accidental insertion into the trachea (min)				
Yes	4 (12.1%)	1 (3.0%)	1.948	0.355
No	29 (87.9%)	32 (97.0%)		

bring the chin closer to the sternum when inserting a gastric tube into a comatose patient, thus increasing the difficulty of catheterization and resulting in more attempts. Clinical nursing staff could benefit from improving their proficiency in the reverse Sellick maneuver, which may enhance success rates and reduce the number of required attempts in intubated patients.

Regarding adverse events of tube placement, there were no statistically significant differences in nasal bleeding and misplacement of the tube in the trachea between the two groups ($p > 0.05$), though there was a significant difference in the twisting or knotting of the nasogastric tube ($p < 0.05$). Nasogastric tube placement is an invasive procedure, and irritation of the surrounding mucosal tissue during placement increases the incidence of mucosal bleeding in the surrounding tissues of the upper respiratory tract [18]. Accidental insertion into the trachea is a serious adverse event of nasogastric tube placement, predisposing patients to cyanosis, respiratory distress, aspiration and even suffocation. In this study, there were four cases of accidental tube entry into the trachea using the traditional technique. In contrast, only one such case occurred using the reverse Sellick maneuver. Although the difference was not statistically significant, the reverse Sellick maneuver markedly reduced the incidence of accidental tube entry into the trachea, compared with the traditional technique. Thus, the reverse Sellick maneuver could be safer for nasogastric tube placement in intubated patients than the traditional technique. The reverse Sellick maneuver and traditional insertion methods can be used for nasogastric tube placement in patients with tracheal intubation in clinical practice. However, nursing staff should receive adequate training and practice in the reverse Sellick maneuver to improve placement success and reduce the risk of complications.

5. Limitations

There were several limitations in this study. A randomized controlled trial was conducted, and nurses were trained and

assessed based on insertion techniques before the study. However, long-term clinical use of the traditional method has resulted in nurses being comparatively less proficient in the reverse Sellick maneuver, which potentially led to bias in the results obtained. Additionally, the sample size was relatively small, though the calculated number of participants (33 per group) was adequate to achieve statistical power. Finally, this was a single-center study, which may limit the generalizability of the findings to other settings or patient populations.

6. Conclusions

In conclusion, our study showed that the success rate and duration of nasogastric tube placement were comparable between the reverse Sellick maneuver and the traditional method in patients with tracheal intubation. The initial placement success rate was slightly lower with the reverse Sellick maneuver than with the traditional technique. However, the reverse Sellick maneuver was associated with reduced nasogastric tube twisting or knotting and with a numerically lower incidence of serious adverse events, particularly accidental tracheal insertion. The small number of cases and the difference in the technique proficiency of the operators between the two methods prevented firm conclusions from being drawn. Therefore, future studies should include a larger sample size, extend the study period, include multicenter participation, and use more homogeneous randomized controlled trials to comprehensively compare the effectiveness and safety of the reverse Sellick maneuver versus the traditional method for nasogastric tube placement in intubated patients.

AVAILABILITY OF DATA AND MATERIALS

The research data used to support the findings of this study are available from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

XLC and JL—conceived the topic and designed the study. DY and YJD—collected the data. XLC and DY—summarized the data and performed the statistical analysis. JL and ML—interpreted the data and drafted the manuscript. ML—made modifications to the spelling, grammar and expression of this manuscript. XLC—revised the manuscript and made the decision to submit for publication. All the authors have agreed to be accountable for the content and conclusions of the article and approved submission.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was approved by the Ethics Committee of West China Hospital, Sichuan University (NO. 2021(1431)). The clinical trial registration was completed with the registration number: ChiCTR2200063982. The study obtained the written informed consent of the patients' family.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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