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A Meta-Analysis of the Effect of Modified Gastric Tube Length on Enteral Nutrition in Stroke Patients

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Abstract: *Objective:* To systematically evaluate the effect of modified length of gastric tube implantation in stroke patients. *Methods:* Randomized controlled studies on the effect of narrative therapy on negative emotions of malignant tumor patients were published in PubMed, EMbase, Web of Science, Cochrane Library, CNKY. Wanfang Data, VIP Database and CBM disc from database establishment to May 2021. RewMan 5.2 software was used for the meta-analysis. *Results:* Ten articles were included, involving 1140 patients in total. Results of meta-analysis showed that improved length of gastric tube implantation could reduce the incidence of aspiration pneumonia in stroke patients with enteral nutrition [OR = 0.18, 95% CI (0.10, 0.31), $P < 0.00001$], reduce gastroesophageal reflux rate (OR = 0.13, 95% CI (0.04, 0.38), $P < 0.0002$], the incidence of aspiration (OR = 0.23, 95% CI (0.11, 0.38), $P < 0.00001$], the incidence of abdominal distension and diarrhea (OR = 0.13, 95% CI (0.06, 0.28), $P < 0.00001$], the incidence of choking cough (OR = 0.20, 95% CI (0.07, 0.61), $P < 0.005$], but no difference between the two groups in terms of reducing gastric residual (OR = 0.10, 95% CI (2.40, 2.60), $P = 0.94$]. *Conclusions:* The modified length of the gastric tube can replace the traditional length of the gastric tube in the application of stroke patients, can reduce the complications of enteral nutrition, is safe and feasible. However, due to the limitation of the quality and quantity of the included studies, we should be cautious about the results of this meta-analysis and expect to carry out more large-sample and high-quality randomized controlled trials for demonstration.

Keywords: Stroke; Length of gastric tube; Modified gastric tube; Meta-analysis; Systematic evaluation; Complications

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1. Introduction

Stroke, as a common cerebrovascular disease, is characterized by high incidence, high disability rate, and high fatality rate [1]. Due to neuromuscular damage, consciousness disorders, and other reasons, stroke patients are often unable to eat by themselves and usually receive nutritional support and medication through enteral nutrition to promote disease recovery [2]. There are many ways to place tubes for enteral nutrition, among which an indwelling gastric tube is the most common approach for enteral nutrition support in clinical practice. In 2019, the Chinese Expert Consensus on Enteral Nutrition Support in Nervous System Diseases recommended nasogastric tubes as the preferred route for enteral nutrition in stroke patients [3]. However, patients are prone to gastrointestinal complications such as nausea, vomiting, reflux, and aspiration during the indwelling nasogastric tube period. Moreover, patients with nervous system diseases often have characteristics such as advanced age, bedridden state, unconsciousness, and swallowing disorders, resulting in poor gastrointestinal motility and inherent risks of reflux and high aspiration. The incidence of gastrointestinal complications in these patients is as high as 48.25% [4]. Studies have shown that different lengths of indwelling gastric tubes have a certain impact on the occurrence of gastrointestinal complications in stroke patients [5]. Currently, the clinically used measurement method for gastric tube placement length adopts the traditional measurement of the distance from “ear lobe to nasal tip to xiphoid process” or “anterior midline hairline to xiphoid process,” which is approximately 45–55 cm [6]. In recent years, several studies have modified the gastric tube placement length by extending it beyond the traditional placement length, achieving better results and reducing the occurrence of gastrointestinal complications. However, there is still no unified evidence or guidelines regarding the optimal placement length. This study aims to systematically evaluate and collect research on modified gastric tube placement lengths for stroke patients from both domestic and international sources, providing evidence support and guidance for clinical practice.

2. Materials and methods

2.1. Inclusion and exclusion criteria for literature

2.1.1. Inclusion criteria

(1) Research subjects: Stroke patients requiring nasogastric tube insertion for nasal feeding.

(2) Intervention measures: Comparison of the effects of modified gastric tube placement length and traditional gastric tube placement length on enteral nutrition in stroke patients. In the studies included in this research, the observation group had four modification methods, including the distance from the eyebrow center to the navel (55–65 cm), the distance from the hairline to the navel (57–67 cm), the distance from the nasal tip via the ear lobe to the xiphoid process of the sternum extended by 15 cm (60–70 cm), and inserting an additional 10 cm after confirming the gastric tube’s position in the stomach during placement, resulting in a length of approximately 58–60 cm. The control group adopted the traditional gastric tube placement length measurement method, namely, the distance from the anterior midline hairline to the xiphoid process or the distance from the nasal tip to the ear lobe to the xiphoid process. Study type: Randomized controlled trials examining the impact of modified gastric tube placement lengths on enteral nutrition complications in stroke patients.

(3) Outcome measures: (a) Incidence of esophageal reflux; (b) Incidence of aspiration; (c) Incidence of abdominal distension and diarrhea; (d) Incidence of aspiration pneumonia; (e) Choking; (f) Gastric residual volume.

(4) Study type: Randomized controlled studies.

2.1.2. Exclusion criteria

Non-English and non-Chinese literature; duplicate publications; retrospective studies, historical control studies, and self-control studies.

2.2. Literature search strategy

To conduct a comprehensive search without limiting to randomized controlled trials, the following search strategies were used: For Chinese databases, the search terms were (nasal feeding tube OR nasogastric tube OR gastric tube OR indwelling gastric tube) AND (length OR depth) AND (stroke OR neurology department OR hemorrhagic stroke OR ischemic stroke OR cerebral thrombosis). These terms were used to search the Chinese Biomedical Literature Database (CBM), China National Knowledge Infrastructure (CNKI), and Wanfang Database. For English databases, the search terms were (insert gastric tube OR nasogastric tube placement OR gastric tube OR stomach tube) AND (stroke OR cerebral infarction) AND (insertion length OR depth OR modified length). These terms were used to search PubMed, Cochrane Library, and Web of Science databases. Both subject headings and free-text terms were combined in the search, and no language restrictions were applied. Additionally, relevant literature and gray literature were searched on the internet, and reference lists of included studies were tracked. The search period was from the inception of each database to May 2021.

2.3. Literature screening and data extraction

Based on the inclusion and exclusion criteria, two researchers independently read the titles and abstracts of the retrieved literature, selected eligible studies, and excluded obviously irrelevant ones. For studies with uncertainty regarding their eligibility, the full texts were read before making a decision. The two researchers cross-checked their results, and any discrepancies were resolved through discussion or by seeking a third party's opinion. The two researchers extracted data using a predesigned data extraction form, including basic information about the literature, characteristics of the study population, intervention measures, intervention intensity, and outcome measures.

2.4. Risk of bias assessment

Two researchers independently evaluated the included studies using the Cochrane Collaboration's risk of bias assessment tool and cross-checked their results. Any disagreements were resolved through discussion or by seeking a third party's opinion. After reaching a consensus, a bias assessment table was created using RevMan 5.2 software. The evaluation included the following aspects: (1) allocation method, (2) allocation concealment, (3) blinding of participants, (4) blinding of outcome assessors, (5) completeness of outcome data, (6) selective reporting of results, and (7) other biases. The assessment items were evaluated as low risk, unclear, or high risk. Studies that fully met the criteria were considered to have a low risk of bias (rated as A), those that partially met the criteria were considered to have a moderate risk of bias (rated as B), and those that did not meet the criteria at all were considered to have a high risk of bias (rated as C). The two researchers rigorously evaluated the quality of the included studies based on these criteria.

2.5. Statistical methods

Statistical analysis was performed using RevMan 5.2. For continuous data, the standardized mean difference (SMD) and 95% confidence interval (CI) were used for evaluation. For categorical data, the odds ratio (OR) and 95% CI were used. Statistical significance was set at $P < 0.05$. Heterogeneity testing was performed: when $P > 0.05$ and I2 < 50%, the studies were considered to have low heterogeneity and a fixed-effects model was used for meta-analysis. When $P < 0.05$ and $I2 > 50\%$, the studies were considered to have high heterogeneity and a random-effects model was used for meta-analysis.

3. Results

3.1. Literature search results

Initially, 1426 articles were retrieved. After removing duplicates and screening based on titles and abstracts, 785 articles were excluded due to being reviews, duplicate publications, non-randomized controlled trials, or not meeting the inclusion criteria. This left 44 articles for further consideration. Upon reading the full texts, 10 well-designed randomized controlled trials were finally included. See **Figure 1** for details.

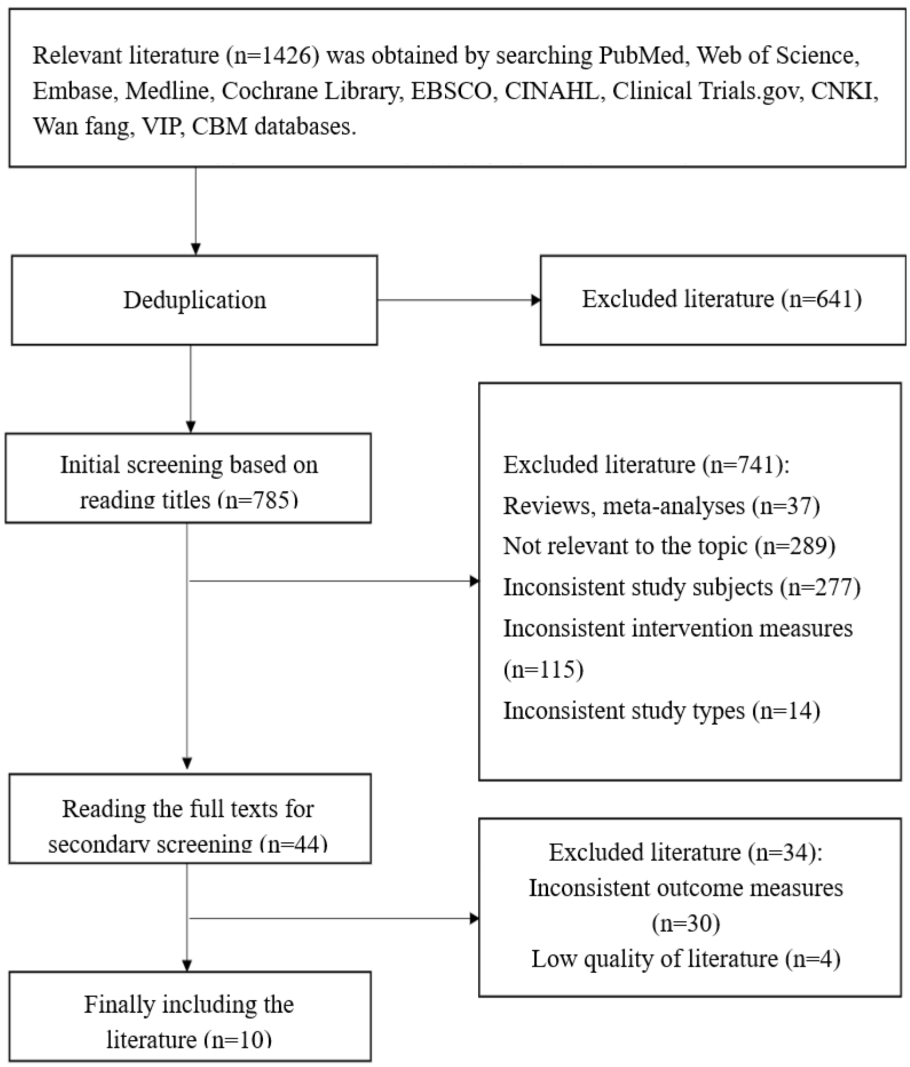

Figure 1. Flowchart of literature screening.

3.2. Basic characteristics of included literature

In this study, a total of 10 articles were included [5,7-15]. The study encompassed 1140 subjects, with 580 in the observation group and 560 in the control group. All studies provided descriptions of both the observation and control group interventions, and the outcome measures were clearly described. The basic characteristics of the included studies are summarized in **Table 1**.

Table 1. Basic characteristics of the included studies' literature

Included studies	Sample size (cases)		Intervention measures		Outcome indicators
	Observation group	Control group	Observation group	Control group	
Luo Chenxiang *et al.* 2019	90	90	Distance from the glabella to the navel on the body surface 55–65 cm	Conventional nasogastric tube length 45–55 cm	①②③④⑤⑥
Xiang Fule *et al.* 2020	28	28	Distance from the hairline to the navel 57–67 cm	Conventional nasogastric tube length 45–55 cm	①②③⑤
Sun Xu *et al.* 2018	54	49	Modified distance from the glabella to the navel on the body surface 55–65 cm	Conventional nasogastric tube length 45–55 cm	⑥
Chen Hongmei *et al.* 2016	60	58	Distance from the tip of the nose, via the earlobe, to the xiphoid process of the sternum, extended by 15 cm (60–70 cm)	Conventional nasogastric tube length 45–55 cm	⑥
Wang Xiumei *et al.* 2018	29	28	After confirming placement within the gastrointestinal tract, insert an additional 10 cm, approximately 58–60 cm	Conventional nasogastric tube length 45–55 cm	①③④
Lu Juan *et al.* 2018	50	50	The insertion depth of the gastric tube is the distance from the hairline to the xiphoid process plus 10 cm, ranging from 55–65 cm	Conventional nasogastric tube length 45–55 cm	①②③⑥
Wu Xiaoyan *et al.* 2006	56	56	Measure the length from the center of the forehead hairline to just below the xiphoid process and add 10 cm, which is 55–65 cm	Conventional nasogastric tube length 45–55 cm	③
Zhang Yuxiang 2011	38	38	Tube insertion length 55–65 cm	Conventional nasogastric tube length 45–55 cm	①④
Chen Chuanjuan 2018	105	105	Distance from the tip of the nose, via the earlobe, to the xiphoid process of the sternum + 10 cm	Conventional nasogastric tube length 45–55 cm	①③⑤
Zuo Jinmei 2016	64	58	Distance from the glabella to the navel on the body surface (55–65 cm)	Conventional nasogastric tube length 45–55 cm	①⑥

Notes: ① Aspiration ② Choking cough ③ Reflux ④ Diarrhea, abdominal distension ⑤ Aspiration pneumonia ⑥ Gastric residual volume.

3.3. Methodological quality evaluation of included literature

Among the 10 included articles, 2 articles [7,10] mentioned block randomization, 3 articles [8,9,11] mentioned randomization using a random number table, and the remaining 5 articles [5,12-15] only mentioned the word "random." None of the articles mentioned allocation concealment or blinding. Based on the Cochrane Collaboration's criteria for evaluating the quality of literature, all included studies were rated as Grade B. See **Figure 2** for specific evaluation results.

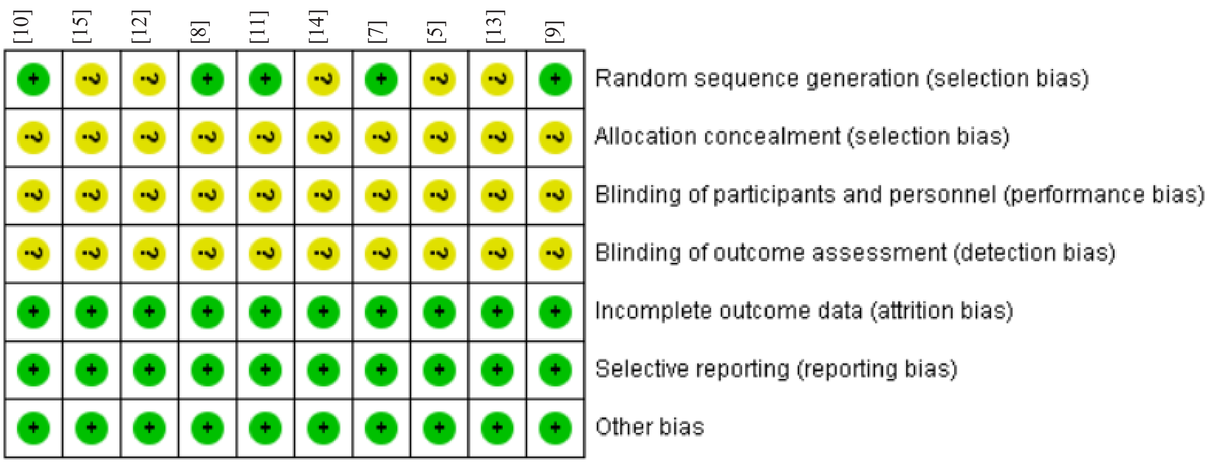

Figure 2. Evaluation Diagram of Literature Quality Risk and Bias.

3.4. Meta-analysis results

3.4.1. Incidence of gastrointestinal aspiration

Seven studies [7-9,11,12,14,15] reported on this factor, and there was no heterogeneity among the studies (I2 = 0%, P = 0.97). A fixed-effects model was selected for analysis. The meta-analysis results showed that OR = 0.18, 95% CI (0.10, 0.31), $P < 0.00001$, indicating that the modified gastric tube insertion length measurement method can reduce the incidence of gastroesophageal aspiration. See **Figure 3**.

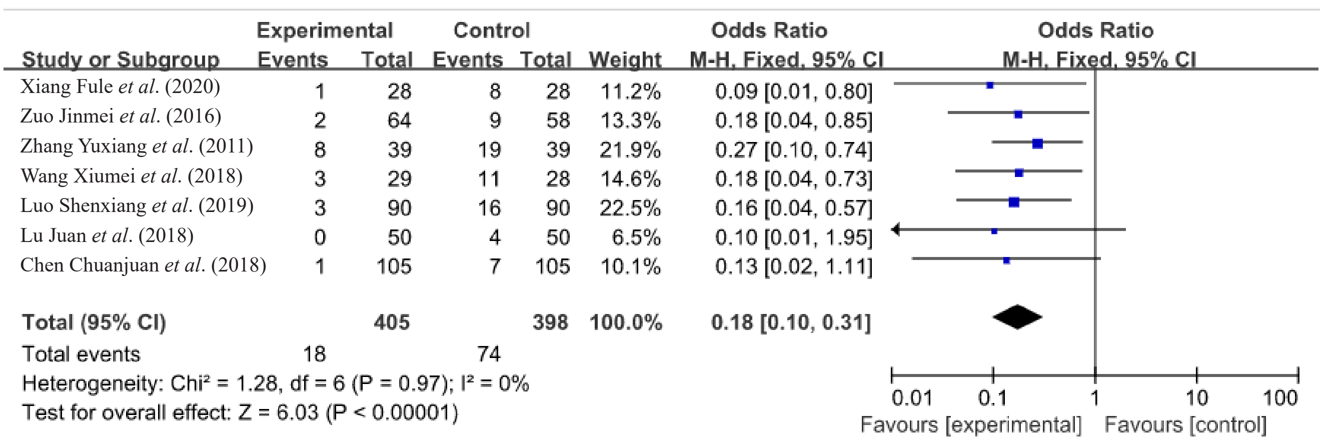

Figure 3. Forest plot of gastrointestinal aspiration incidence.

3.4.2. Incidence of gastroesophageal choking cough

Three studies [8,9,12] reported this factor, and there was no heterogeneity among the studies (I2 = 0%, P = 0.73). A fixed-effects model was selected for analysis. The meta-analysis results showed that OR = 0.13, 95% CI (0.04, 0.38), $P < 0.0002$, indicating that the modified gastric tube insertion length measurement method can reduce the incidence of gastroesophageal choking cough. See **Figure 4**.

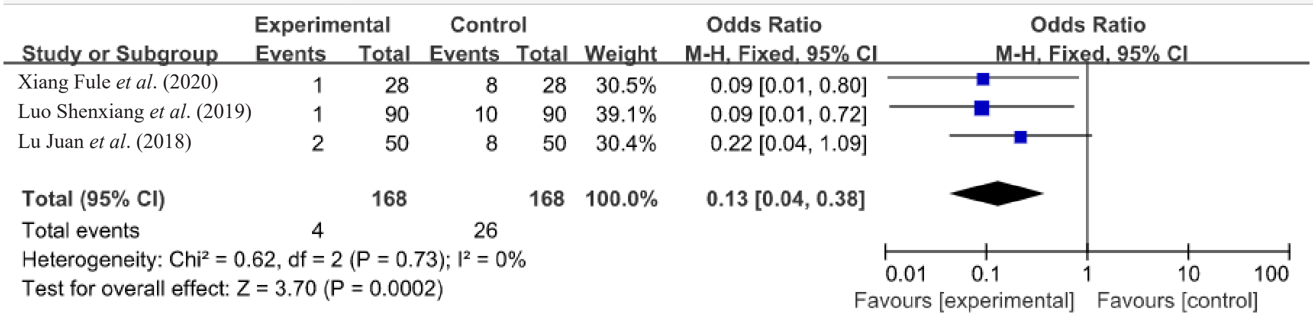

Figure 4. Forest plot of gastroesophageal choking cough incidence.

3.4.3. Gastroesophageal reflux rate

Eight studies [7–12,14,15] reported on this factor, and there was no heterogeneity among the studies (I2 = 28%, P = 0.21). A fixed-effects model was selected for analysis. The meta-analysis results showed that OR = 0.23, 95% CI (0.11, 0.38), $P < 0.00001$, indicating that the modified gastric tube insertion length measurement method can reduce the incidence of gastroesophageal reflux rate. See **Figure 5**.

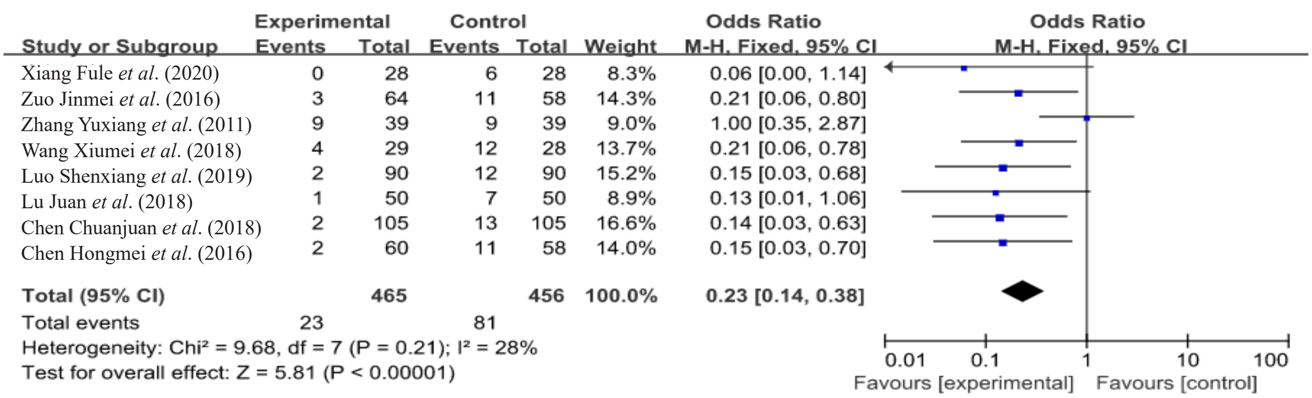

Figure 5. Forest plot of gastrointestinal reflux incidence.

3.4.4. Incidence of diarrhea and abdominal distension

Two studies [11,14] reported on this outcome measure. The heterogeneity result showed that I2 = 0%, P = 0.60, indicating acceptable heterogeneity among the studies. A fixed-effects model was selected for analysis. The meta-analysis results revealed that OR = 0.13, 95% CI (0.06, 0.28), $P < 0.00001$. This suggests that the modified gastric tube insertion length measurement method has a lower incidence of abdominal distension and diarrhea compared to traditional measurement methods. See **Figure 6**.

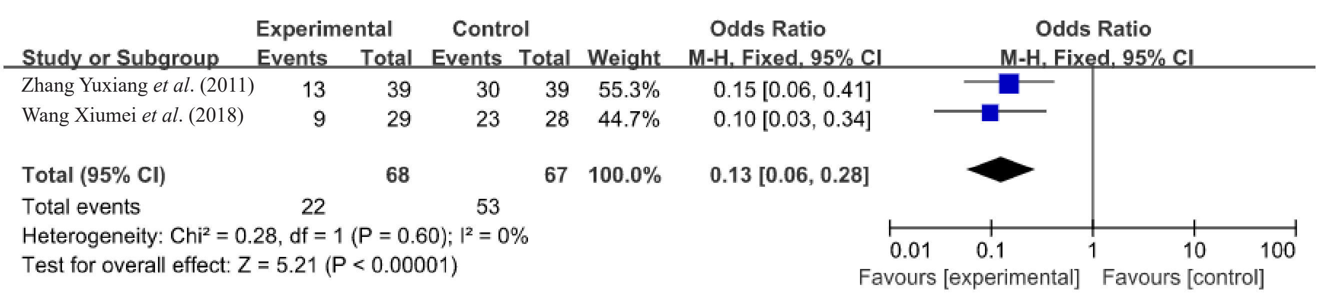

Figure 6. Forest plot of gaurestrointestinal abdominal distension and diarrhea incidence.

3.4.5. Incidence of aspiration pneumonia

Three studies [9,12,15] investigated this factor. There was little heterogeneity among the studies (I2 = 0%, *P* = 0.79), so a fixed-effects model was chosen. The meta-analysis results showed that OR = 0.20, 95% CI (0.07, 0.61), *P* < 0.005, indicating no statistically significant difference between the observation group and the control group. Both groups had similar effects on reducing the incidence of aspiration pneumonia. See **Figure 7**.

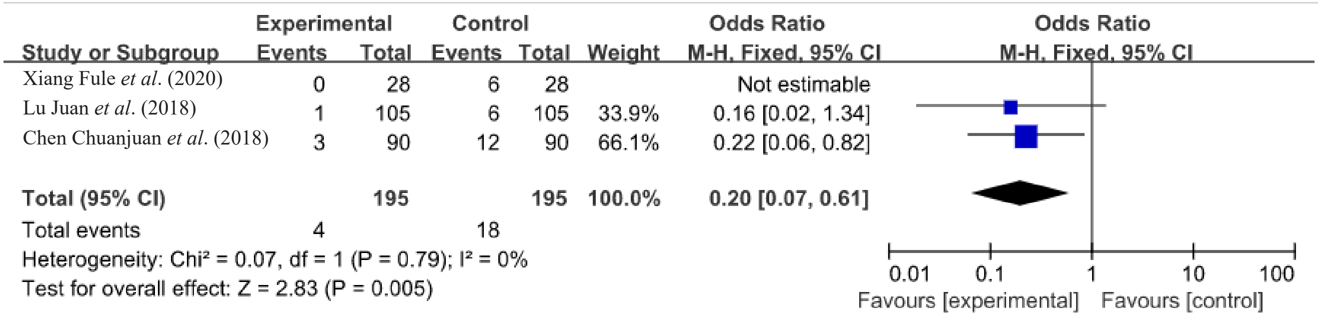

Figure 7. Forest plot of aspiration pneumonia incidence.

3.4.6. Monitoring of gastric residual volume

Five studies [5,7,8,10,12] reported on this factor, and there was no heterogeneity among the studies (I2 = 99%, *P* = 0.94). A fixed-effects model was selected for analysis. The meta-analysis results showed that OR = 0.10, 95% CI (-2.40, 2.60), *P* = 0.94, indicating that the modified gastric tube insertion length had no statistically significant effect on the monitoring of gastric residual volume. See **Figure 8**.

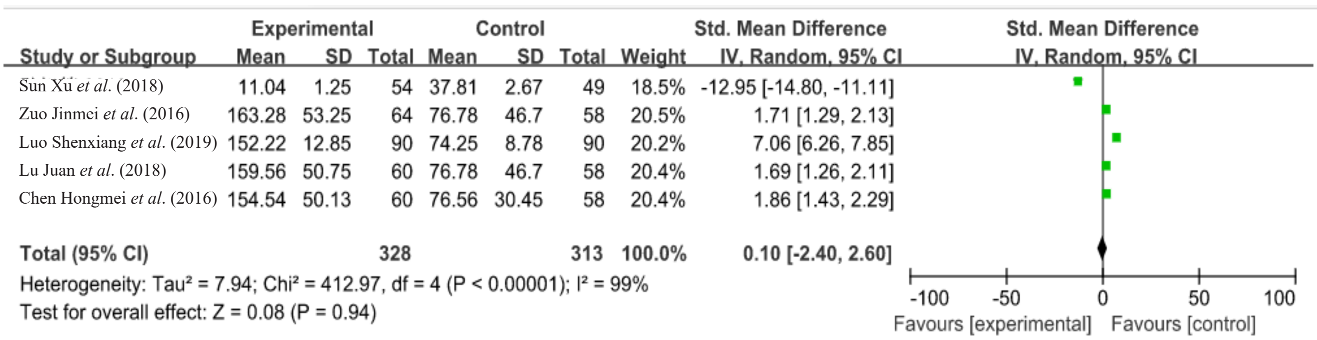

Figure 8. Forest plot of gastric residual volume.

4. Discussion

Currently, the clinically recommended length for gastric tube insertion in adults is typically the distance from the patient's nasal tip to the earlobe and then to the xiphoid process of the sternum, which is generally 45–55 cm [16]. However, some studies have suggested that the traditional nasogastric tube insertion length ignores the anatomical characteristics of the human body, and the insertion position can only reach the gastric cardia, which may not achieve the best effect and is prone to complications [17]. It is believed that it is necessary to increase the insertion length on a traditional basis to ensure that all side holes are within the stomach and to ensure patient safety [18]. This meta-analysis included 10 studies that investigated the modified gastric tube insertion length as an intervention for stroke patients. The results showed that the modified gastric tube insertion length could reduce the incidence of reflux, choking cough, aspiration, abdominal distension and diarrhea, and aspiration pneumonia in stroke patients. There was no statistically significant difference in gastric residual volume. Therefore, the modified gastric tube insertion length can be used as an alternative to the traditional tube insertion length in clinical practice for stroke patients.

4.1. Methodological quality evaluation of included studies

After rigorous screening, 10 studies [5,7-15] were finally included, all of which were from China. The quality grade of the articles without relevant content abroad was B. Among the four studies that met the inclusion criteria, three reported baseline comparability. All studies performed baseline comparisons of the subjects' general information, and the results showed no statistical significance in baseline data ($P < 0.05$). Five studies [7-11] reported specific randomization methods, while five studies [5,12-15] only mentioned randomization grouping without specifying the randomization method. None of the studies reported allocation concealment or blinding. Studies have shown that not concealing the allocation scheme can directly lead to selection bias, and the reduction in the odds ratio can be exaggerated by 30% in trials with unclear allocation concealment and by 41% in trials with inadequate concealment. Therefore, although the results of this meta-analysis suggest that the modified gastric tube insertion length can reduce the incidence of reflux, choking cough, aspiration, abdominal distension and diarrhea, and aspiration pneumonia in stroke patients receiving nasogastric feeding, due to the low quality of some studies and the unclear concealment method of the random allocation scheme, there may be possibilities of selection bias, implementation bias, attrition bias, and measurement bias, which directly affect the reliability and argument strength of the meta-analysis results.

4.2. Analysis of the effect of modified gastric tube insertion length in stroke patients

The results of this meta-analysis study showed that the modified gastric tube insertion length for enteral nutrition in stroke patients can reduce the incidence of aspiration pneumonia, gastroesophageal reflux, aspiration, abdominal distension, diarrhea, and choking cough. However, there was no significant difference between the two groups in measuring gastric residual volume. For patients with cerebral infarction, especially those who are bedridden for long periods, maintaining good nutrition supply can improve the body's immunity and promote disease recovery. Indwelling gastric tubes have become an important way for their nutritional supply. The length of conventionally indwelling gastric tubes is 44–55 cm, and the length of the nasopharynx and esophagus of the body is about 45–55 cm. If the tube insertion length is set within this range, it may be affected by factors such as sphincter relaxation and weakened esophageal reflux barrier ability. When the patient's position is low, it can easily induce food reflux and gradually cause harm such as gastritis and pneumonia. According to physiological anatomy theory, the entire stomach from the cardia to the pylorus still has a height of 10–15 cm. Increasing the length of the tube insertion can fully reach the end of the nasogastric tube into the stomach, allowing the nasogastric feeding contents to quickly reach the pylorus of the stomach, reducing gastric reflux, and more helping patients to empty and digest, reducing the occurrence of complications such as choking cough [19,20]. At the same time, it is also beneficial to better detect gastric residues when withdrawing the gastric residual volume. However, there is currently much debate about the extended length of the gastric tube, and the modified gastric tube lengths included in this study are not all the same. They are the surface distance from the glabella to the navel of 55–65 cm, the distance from the hairline to the navel of 57–67 cm, the surface distance from the tip of the nose via the earlobe to the xiphoid process of the sternum extended by 15 cm (60–70 cm), and determining the insertion of an additional 10 cm in the gastrointestinal tract during gastric tube placement, about 58–60 cm. The results of this study showed that the modified gastric tube length had more advantages over the conventional length in the incidence of enteral nutrition complications in stroke patients, which could reduce the incidence of aspiration pneumonia, gastroesophageal reflux, aspiration, abdominal distension, diarrhea, and choking cough. However, there is still little research on the optimal length of the modified gastric tube. Chen Hongmei's study pointed out that the length of the indwelling gastric tube should be selected based on individual characteristics, and the length of the gastric tube is related to the patient's height. It is suggested to select the surface distance from the patient's glabella to the navel. This measurement method is simple and suitable for patients of different height groups [21,22]. Zuo Jinmei's [11] study compared two different modified methods (the distance from the glabella to the navel and the surface distance from the tip of the nose via the earlobe to the xiphoid process of the sternum extended by 15 cm) with the conventional gastric tube length. The results indicated that there was no difference between the two lengths of the modified gastric tube in terms of enteral nutrition complications and the accuracy of gastric residual volume monitoring, and the modified method from the glabella to the navel was recommended. Thus, it can be seen that the modified gastric tube length is superior to the traditional gastric tube length in enteral nutrition for stroke patients, and further research is still needed to explore the optimal length of the modified gastric tube.

4.3. Limitations and implications of this study

Limitations of this study

(1) Due to limited conditions, gray literature searches were not conducted.

(2) Some of the included studies were small-sample randomized controlled trials.

(3) The quality of the included studies needs to be improved, such as clearly stating the method of random grouping, allocation concealment scheme, and setting of blinding methods.

(4) There were differences in the methods of nasogastric tube placement among the included studies.

Implications:

(1) Future studies should follow the Consolidated Standards of Reporting Trials (CONSORT) as much as possible to improve the reporting quality of clinical randomized controlled trials.

(2) The characteristics of study subjects and quality control methods should be described in detail as much as possible.

(3) Large-sample, multi-center randomized controlled trials should be conducted as much as possible to facilitate clinical promotion.

5. Summary

In summary, current evidence suggests that modified gastric tube insertion length for stroke patients can replace traditional gastric tube insertion length, which is safe and feasible and can reduce the incidence of complications. However, due to the limitations of the quality and quantity of the included studies, a cautious attitude should be maintained towards the results of this meta-analysis, and further methodological improvements are needed in future research. The optimal length of gastric tube insertion for stroke patients should be clarified in nursing research and practice and applied in clinical settings to reduce complications and improve the quality of life for stroke patients.

Disclosure statement

The authors declare no conflict of interest.

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