Duodenal versus gastric feeding in patients with traumatic brain injury: a systematic review and meta-analysis

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Abstract

Introduction: Enteral nutrition support is very important to improve the prognosis of patients with traumatic brain injury (TBI). We aimed to assess the role of duodenal versus gastric feeding in TBI patients, to provide insights into the clinical practice and nursing care.
Material and methods: We searched PubMed and other databases for randomized controlled trials (RCTs) on the role of duodenal versus gastric feeding in TBI patients up to December 15, 2021. The Cochrane Collaboration risk of bias tool was used to assess the methodological quality and risk of bias of included studies. The RevMan 5.3 software was used for data analysis, risk rate (RR) or mean differences (MDs) with 95% confidence interval (CI) were calculated, and publication bias was evaluated by funnel plots.
Results: A total of 16 RCTs were included in this meta-analysis. Synthesized outcomes indicated that compared with gastric feeding, duodenal feeding is beneficial to reduce the incidence of pneumonia (RR = 0.46, 95% CI: 0.38, 0.57), aspiration (RR = 0.30, 95% CI: 0.14, 0.63), reflux esophagitis (RR = 0.25, 95% CI: 0.17, 0.38), diarrhea (RR = 0.58, 95% CI: 0.44, 0.77), and abdominal distension (RR = 0.41, 95% CI: 0.25, 0.68); no significant difference in mortality (RR = 0.85, 95% CI: 0.50, 1.47, $p = 0.57$) was found. Egger's regression test indicated that there was no publication bias in the synthesized outcomes (all $p > 0.05$).
Conclusions: Duodenal feeding may be superior to gastric feeding in the treatment and nursing care of TBI patients with fewer complications. Future studies with a larger sample size and rigorous design are needed to further elucidate the effects and safety of duodenal versus gastric feeding.

Key words: traumatic brain injury, duodenal feeding, gastric feeding, enteral nutrition, care, nursing.

Introduction

Patients with traumatic brain injury (TBI) are in a state of high decomposition and high metabolism due to the traumatic stress response, resulting in an imbalance of the body's nitrogen metabolism [1, 2]. The clinical manifestations include malnutrition, immune function damage, and eventually pulmonary infection [3]. Proper nutritional support can improve the nutritional status of patients with TBI, strengthen the immune function, and reduce the concurrent pulmonary infections [4]. Clinically, enteral nutrition support and parenteral nutrition support can be used, but parenteral nutrition support is not conducive to maintenance of the physiological functions of the digestive tract [5]. Therefore, the nutritional support and care of TBI patients are of great significance for the prognosis of patients.

Enteral nutrition support has gradually become a common clinical nutritional support method. The clinical applications of enteral nutrition are mainly gastric and duodenal feeding. Previous studies [6, 7] have shown that patients treated by nasogastric tube are prone to gastric retention and gastroesophageal reflux, aspiration, pneumonia and many other complications, but the procedure is relatively simple, the cost is relatively low, and it is widely used in clinical practice [8]. Duodenal feeding has been reported to be safer yet it is more expensive [9]. Several previous studies [10–12] have focused on the use of duodenal versus gastric feeding for enteral nutrition support. However, the related results remain inconsistent. Understanding the advantages and disadvantages of duodenal versus gastric feeding is beneficial to provide evidence for the clinical nursing care and treatment of enteral nutrition. Therefore, we aimed to conduct a meta-analysis to evaluate the risk ratio of complications associated with duodenal versus gastric feeding in TBI patients, to provide insights to the clinical management and nursing care of TBI.

Material and methods

We conducted and reported this systematic review and meta-analysis based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [13].

Literature search strategy

Two authors independently searched PubMed, OVID, Cochrane Library, Clinical trials, China National Knowledge Infrastructure (CNKI) and Wanfang databases for RCTs on the role of duodenal versus gastric feeding for enteral nutrition support. The search time limit was from the establishment of the databases to December 15, 2021. The search terms used were as follows: ("traumatic brain injury" OR "severe brain injury" OR "brain injury" OR "TBI") AND ("enteral nutrition" OR "nasogastric tube" OR "nasal-intestinal tube" OR "duodenal feeding" OR "gastric feeding").

Inclusion and exclusion criteria

The inclusion criteria for this study were as follows: Study type: Randomized controlled trials (RCTs) on the effects and safety of duodenal versus gastric feeding in TBI patients. Research patients: TBI patients with Glasgow Coma Score (GCS) ≤ 8. Intervention measures: comparison of duodenal versus gastric feeding in TBI patients. The intervention duration and frequency of enteral nutrition were not limited. Outcome indicators: The article reports related outcome indicators for complications including incidence of pneumonia, reflux esophagitis, aspiration, abdominal distension, and diarrhea. We excluded duplicate publications and low-quality literature reports.

Literature screening and data extraction

Two researchers developed standardized data extraction tables based on inclusion, exclusion criteria, and literature content, and conducted literature screening. The data extracted by this meta-analysis included the study population (inclusion criteria and exclusion criteria, grouping methods and processes, sample size), sampling methods, intervention methods (intervention context, duration, and frequency), and outcome indicators. In case of disagreement, it was solved through discussion or arbitration by the third researcher.

Quality evaluation

We adopted the Cochrane Collaboration risk of bias tool to assess the methodological quality and risk of bias of included studies. Any disagreements in the quality evaluation were solved by further discussion and consensus. The tool assessed seven specific domains: sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting and other issues. Every domain could be classified as low risk of bias, high risk of bias or unclear risk of bias in compliance with the judgment criteria.

Statistical analysis

All the statistical analyses were conducted with RevMan 5.3 software. All the collected data were double-checked by two authors. Data syntheses and interpretations were also conducted by two authors to ensure the accuracy of the results. All the binary outcomes were presented as the Mantel-Haenszel risk rate (RR) with 95% confidence interval (CI). Continuous outcomes were shown as mean differences (MDs). We applied the fixed-effect model in the cases of homogeneity (*p*-value of χ^2 test >10 and I^2 < 50%), and we used a random-effect model in cases of obvious heterogeneity (*p*-value of χ^2 test > 0.10 and $I^2 \geq 50\%$). Publication bias was evaluated by funnel plots, and asymmetry was assessed by conducting Egger's regression test. $P < 0.05$ indicated that the differences were statistically different.

Results

Search outcome

The process for study inclusion is shown in Figure 1. The first search identified 179 potentially relevant studies. Of these identified reports, 18 studies were excluded as duplicates. After viewing the titles and abstracts of the 161 remaining studies, the full texts of 38 RCTs were retrieved. Among them, 22 studies were excluded due to failure to meet the inclusion criteria. Finally, 16 RCTs [10–12, 14–26] were included in this meta-analysis.

Characteristics and quality of included RCTs

Of the included 16 RCTs [10–12, 14–26], a total of 1294 TBI patients received enteral nutrition, specifically 641 patients accepted gastric feeding and 653 patients accepted duodenal feeding. The countries of included studies included Spain, the USA, Canada, the UK and China. The numbers of included participants among studies ranged from 27 to 246. The detailed characteristics of included RCTs are presented in Table I.

The risk of bias graph of included RCTs is presented in Figures 2 and 3. All the included RCTs mentioned randomization; two RCTs [14, 26] did not provide a detailed description of the methods used to produce a random sequence. Only two studies [19, 20] reported allocation blinding, and all the other included RCTs did not report allocation blinding or personnel blinding. No study reported blinding of outcome assessment. No other selective reporting or other significant bias amongst the 16 included RCTs was found.

Primary outcome

Incidence of pneumonia

Eleven studies [10, 12, 14–17, 20, 22, 24–26] reported the incidence of pneumonia in the two groups of patients. There was no significant heterogeneity among the studies (I^2 = 42%, p = 0.07). We used a fixed-effect model for meta-analysis. The synthesized results showed that the incidence of pneumonia in TBI patients with duodenal feeding was significantly lower than that of gastric feeding (RR = 0.46, 95% CI: 0.38, 0.57, p < 0.001, Figure 4 A).

Incidence of aspiration

Seven studies [10, 12, 18, 19, 23–25] reported the incidence of aspiration in the two groups of patients. There was no significant heterogeneity among the studies (I^2 = 0%, p = 1.00). We used a fixed-effect model for meta-analysis. The synthesized results showed that the incidence of aspiration in TBI patients with duodena feeding was significantly lower than that of gastric feeding (RR = 0.30, 95% CI: 0.14, 0.63, p = 0.002, Figure 4 B).

Incidence of reflux esophagitis

Nine studies [10, 12, 18, 19, 23–25] reported the incidence of reflux esophagitis in the two groups of patients. There was no significant het-

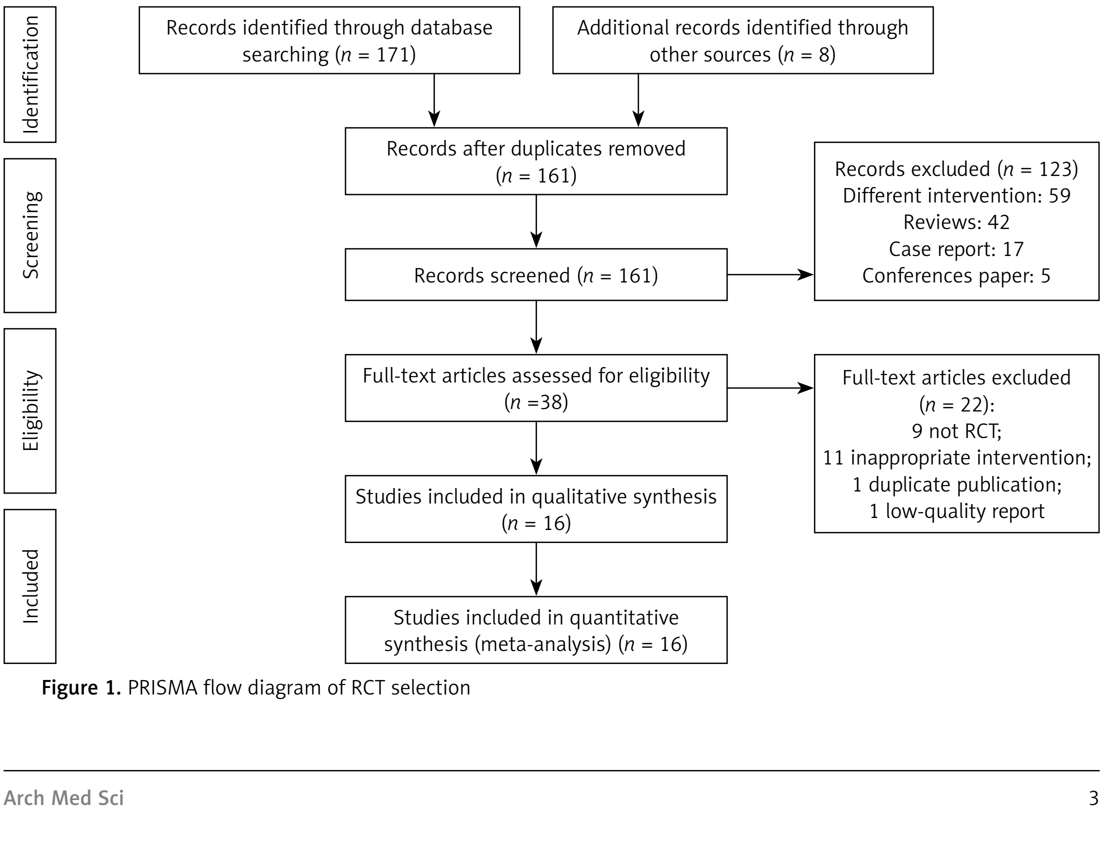

Figure 1. PRISMA flow diagram of RCT selection

Table I. Characteristics of included RCTs

Study ID	Country	Sample size		Feeding intervention
Acosta-Escribano 2010 [10]	Spain	50	54	Inserted within 24 h after admission. Both groups received 105 kJ/(kg day) calories, 0.2 g N/(kg day)
Qiaoling 2013 [20]	China	90	85	Inserted within 48 h after admission. Enteral nutrition was given on the second and third day based on 60% and 80% of the calorie requirement, and after the fourth day, enteral nutrition provided 80% of body needs
Xuping 2007 [23]	China	16	18	Inserted within 24 h after TBI, gradually transition from 500 ml/day on the first day to 1500 ml/day, and the instillation time was not less than 16 h/day
Grahm 1989 [14]	USA	17	15	Inserted within 36 h after admission, infused at a rate of 70–100 ml/h
Hsu 2009 [15]	China	59	62	The initial rate was 20 ml/h, and the rate was increased by 20 ml/h every 4 h until the rate was stable after meeting the calorie demand of the body
Kortbeek 1999 [16]	Canada	37	43	Inserted within 72 h after admission, the initial rate was 25 ml/h, and the rate was increased by 25 ml/h every 4 h, until meeting the body's calorie demand
Yanfen 2010 [24]	China	27	30	Inserted within 24 h after TBI, 500 ml feeding was given on the first day, gradually increasing to 1500 ml on the 3rd day, and maintained at 1500 ml/day
Linlin 2020 [17]	China	123	123	Inserted within 48 h after TBI, gave 1/3 of the required amount on the 1st day, 2/3 within 24 h on the 2nd day, and provided all the physiological requirements from the 4th day
Minard 2000 [18]	USA	12	15	Inserted within 72 h after admission, and both groups received 88kJ/(kg·day) calorie
Dongmei 2010 [12]	China	30	30	Inserted within 24 h after TBI, 500 ml feeding was given on the first day, gradually increasing to 1500 ml on the 3rd day, and maintained at 1500 ml/day
Zhihui 2017 [26]	China	45	45	Inserted within 48 h after TBI, and 50% of the total calories were started to increase by 1/4 daily to 100%
Taylor 1999 [22]	UK	41	41	Inserted within 72 h after TBI, and both groups received 63 kJ/h calories and gradually increased to the specified maximum rate
Changyan 2015 [11]	China	30	30	Inserted within 24 h after admission, the rate on the first day was 20 ml/h, and the daily increase was 20 ml/h to 100 ml/h
Yuqiong 2016 [25]	China	40	38	Inserted within 24 h after TBI, 20 ml/h on the first day, increasing by 20 ml/h every day to a stable rate
Shulan 2007 [21]	China	24	24	Inserted within 4 days after admission, instilled continuously at a rate of 40 to 60 ml/h, increasing by 25 ml/h every 8 h until it reached 100 to 125 ml/h
Ningzhen 2010 [19]	China	25	26	Inserted within 24 h after TBI. The actual daily supply of calories was basal energy metabolism ×1.3, and the ratio of non-protein calories to nitrogen was 130 : 1. On the first day, the supply of 1/3 of the total amount of the day would gradually increase, and the transition to total enteral nutrition would be within 3 to 5 days

erogeneity among the studies (I^2 = 0%, p = 0.88). We used a fixed-effect model for meta-analysis. The synthesized results showed that the incidence of reflux esophagitis in TBI patients with duodenal feeding was significantly lower than that of gastric feeding (RR = 0.25, 95% CI: 0.17, 0.38, p < 0.001, Figure 4 C).

Incidence of diarrhea

Six studies [17, 20, 21, 23, 24, 26] reported the incidence of diarrhea in the two groups of patients. There was no significant heterogeneity among the studies (I^2 = 0%, p = 0.98). We used a fixed-effect model for meta-analysis. The synthesized results showed that the incidence of diarrhea in TBI patients with duodenal feeding was significantly lower than that of gastric feeding (RR = 0.58, 95% CI: 0.44, 0.77, p < 0.001, Figure 5 A).

Incidence of abdominal distension

7 studies [10, 11, 18, 19, 21, 23, 25] reported the incidence of abdominal distension in the two

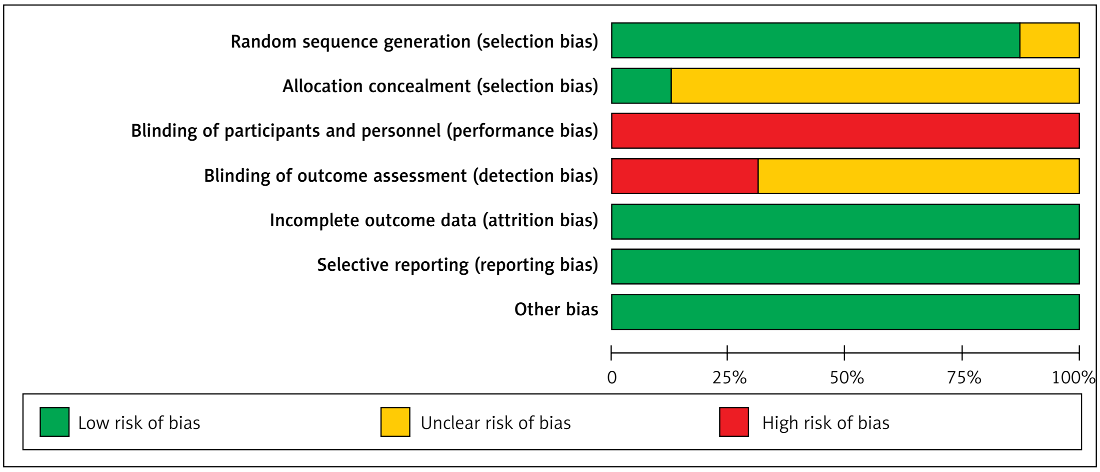

Figure 2. Risk of bias graph

groups of patients. There was no significant heterogeneity among the studies (I^2 = 0%, *p* = 0.75). We used a fixed-effect model for meta-analysis. The synthesized results showed that the incidence of abdominal distension in TBI patients with duodenal feeding was significantly lower than that of gastric feeding (RR = 0.41, 95% CI: 0.25, 0.68, p < 0.001, Figure 5 B).

Mortality

Nine studies [11, 12, 17, 19–21, 23, 24, 26] reported the mortality in the two groups of patients. There was no significant heterogeneity among the studies (I^2 = 0%, *p* = 1.00). We used a fixed-effect model for meta-analysis. The synthesized results showed that there was no significant difference in the mortality between the two groups (RR = 0.85, 95% CI: 0.50, 1.47, *p* = 0.57, Figure 5 C).

The funnel plots of synthesized outcomes are presented in Figure 6. The dots were evenly distributed in the funnel plots, and Egger's regression test indicated that there were no significant differences in the synthesized outcomes (all p > 0.05).

Sensitivity analyses, which investigate the influence of one study on the overall risk estimate by removing one study in turn, suggested that the overall risk estimates were not substantially changed by any single RCT.

Discussion

The acute stage of TBI is a critical stage for various secondary pathological changes. In this stage, patients cannot eat for a long time and their metabolic rate is significantly higher than that of the normal status, which is likely to cause malnutrition, low immunity, and infection [27–29]. Therefore, reasonable nutritional support plays an important role in patients with TBI. Metabolic support is divided into enteral nutrition and parenteral nutrition. Most patients with TBI have

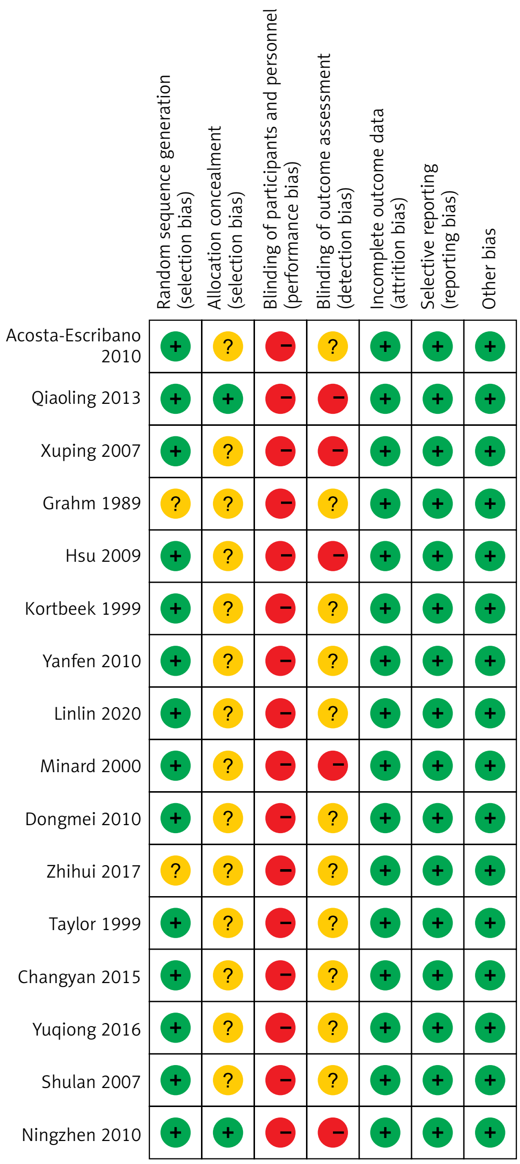

Figure 3. Risk of bias summary

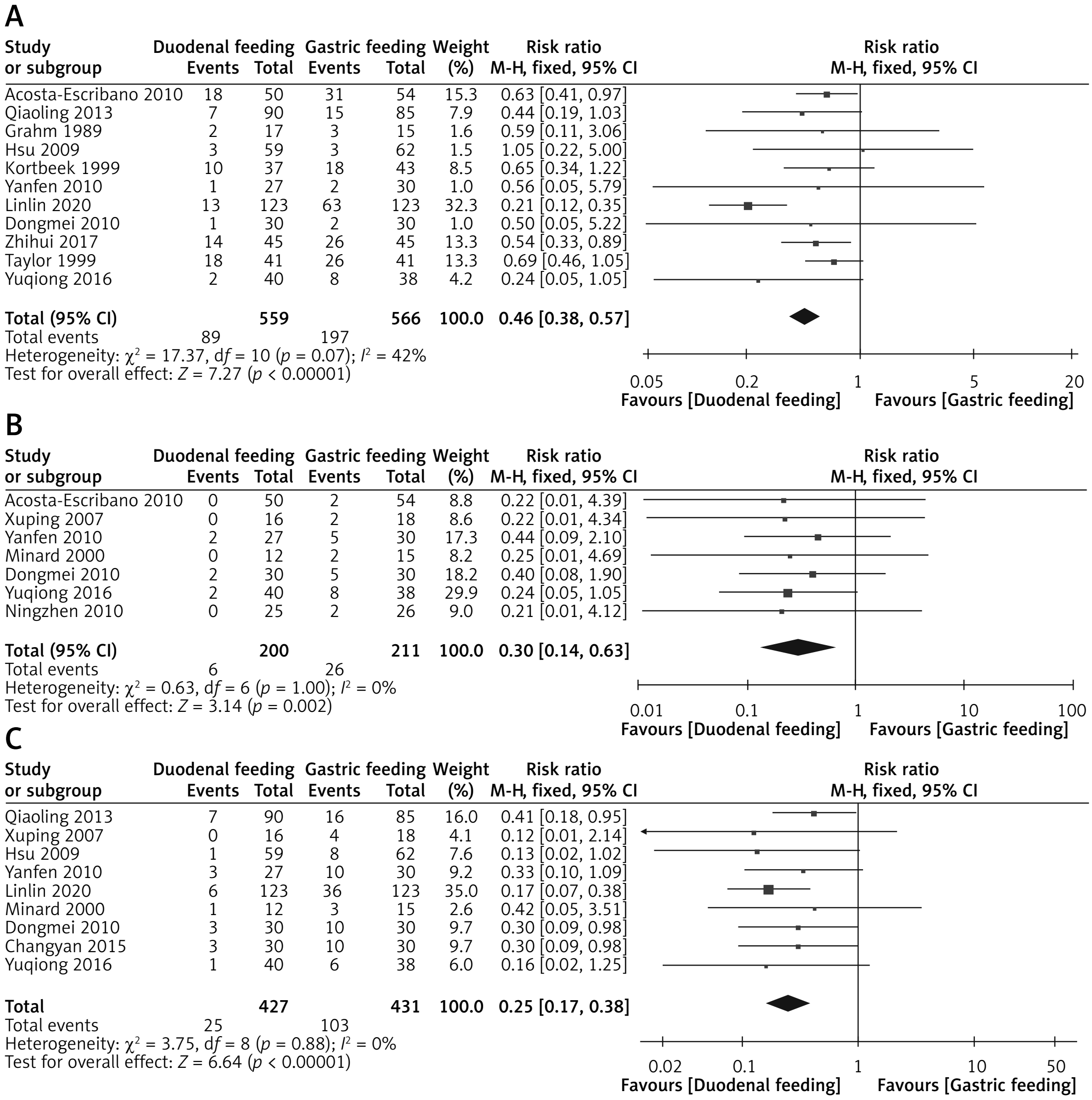

Figure 4. Forest plots for synthesized outcomes: **A** – Forest plot for the incidence of pneumonia, **B** – Forest plot for the incidence of aspiration, **C** – Forest plot for the incidence of reflux esophagitis

impaired gastrointestinal function, and enteral nutrition is often used for nutrition support [30]. The ways of enteral nutrition include nasogastric tube, nasointestinal tube, pharyngostomy tube, and stomach fistula placement. Different enteral nutrition methods can produce different complications related to catheterization, such as reflux, vomiting and aspiration pneumonia, etc. [31–33]. The results of this meta-analysis showed that duodenal feeding is advantageous over gastric feeding for TBI patients in that it reduces the incidence of pneumonia, aspiration, reflux esophagitis, abdominal distension, and diarrhea, and it may be a better option for the enteral nutrition support of TBI patients.

In various clinical diagnoses and treatment, a gastric tube has been placed for gastrointestinal pressure reduction, enteral nutrition support, and drug administration [34]. Swallowing dysfunction is very common in TBI patients [35]. It has been reported that the long-term placement of a gastric tube will entail a risk of vocal paralysis. The emergence of nasal-intestinal tubes is expected to make up for the limitations of nasal stomach tubes. In the past, many studies have shown that in some critical diseases the stomach cannot withstand nutritional support or high reflux risk, such as esophageal fistula, etc. [36–38]. Furthermore, the naso-intestinal feeding would be beneficial in terms of pain relief and patient comfort [39, 40]. Previous meta-analyses [36, 41] have shown that duodenal feeding is beneficial to increase the quality of life for TBI patients, and it is an effective way to provide nutritional support, which is consistent with our findings.

TBI leads to intracranial high pressure and hypothalamus autonomic nerve dysfunction, which can easily cause gastrointestinal motility dysfunc-

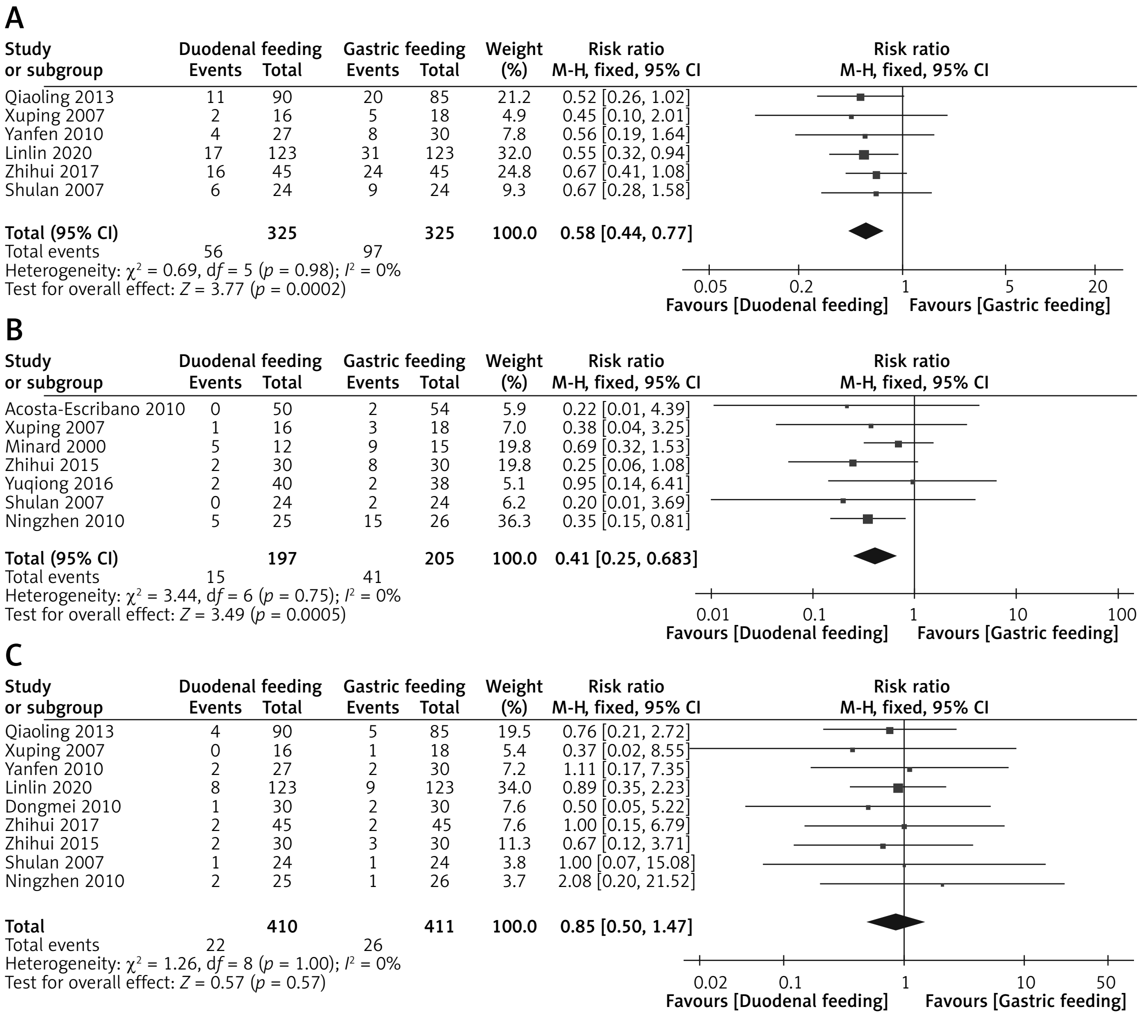

Figure 5. Forest plots for synthesized outcomes: **A** – Forest plot for the incidence of diarrhea, **B** – Forest plot for the incidence of abdominal distension, **C** – Forest plot for the mortality

tion, mainly manifested as stomach and proximal duodenal dysfunction. With the increased amount of gastric retention, the gastric emptying time is prolonged, which is an important source of complications including reflux and abdominal distention [42, 43]. The distal duodenal and null intestines are different from near-end duodenal and stomach, and the function is relatively small [44]. For critically ill patients, the pulmonary infection is associated with the refractive flow of the stomach contents [45]. Moreover, it has been reported that the nasal tube placement can increase the absorption of intestinal mucosal nutrients. Inhibiting the reproduction of pathogens, and effectively avoiding the occurrence of intestinal infections and flora shifts, are beneficial for the prevention of pulmonary infections [46].

Previous studies [47, 48] have shown that both duodenal and gastric feeding are beneficial to improve the nutritional status of TBI patients, but the improvement effect of duodenal feeding is better. The main reasons may be that due to major traumatic stress, TBI patients always are in high metabolism, the body storage energy is reduced, the energy supplement is required, and the intestinal nutrient liquid used in clinical practice provides nutrients that can be directly absorbed, but gastric feeding is injected into the stomach, and stomach digestion is needed, which may damage some of the nutrients due to gastric acid damage [49]. Furthermore, the stomach nutrients also need to pass the nutrient solution to the small intestine by gastrointestinal creep [41, 50]. This process may lose some nutrients. Duodenal feeding directly slightly passes the stomach, directly absorbing nutrients via the small intestine, avoiding the loss of nutrients, and thereby having better effects for nutrition support [51].

Many limitations in this present meta-analysis must be considered. Firstly, there are differences in the timing of placement and the enteral nutrition support plans, and the sample sizes of included RCTs are not large. Secondly, there is some heterogeneity of synthesized outcomes, limited by sample size and collected data, so we could not perform a subgroup analysis. Thirdly, no included

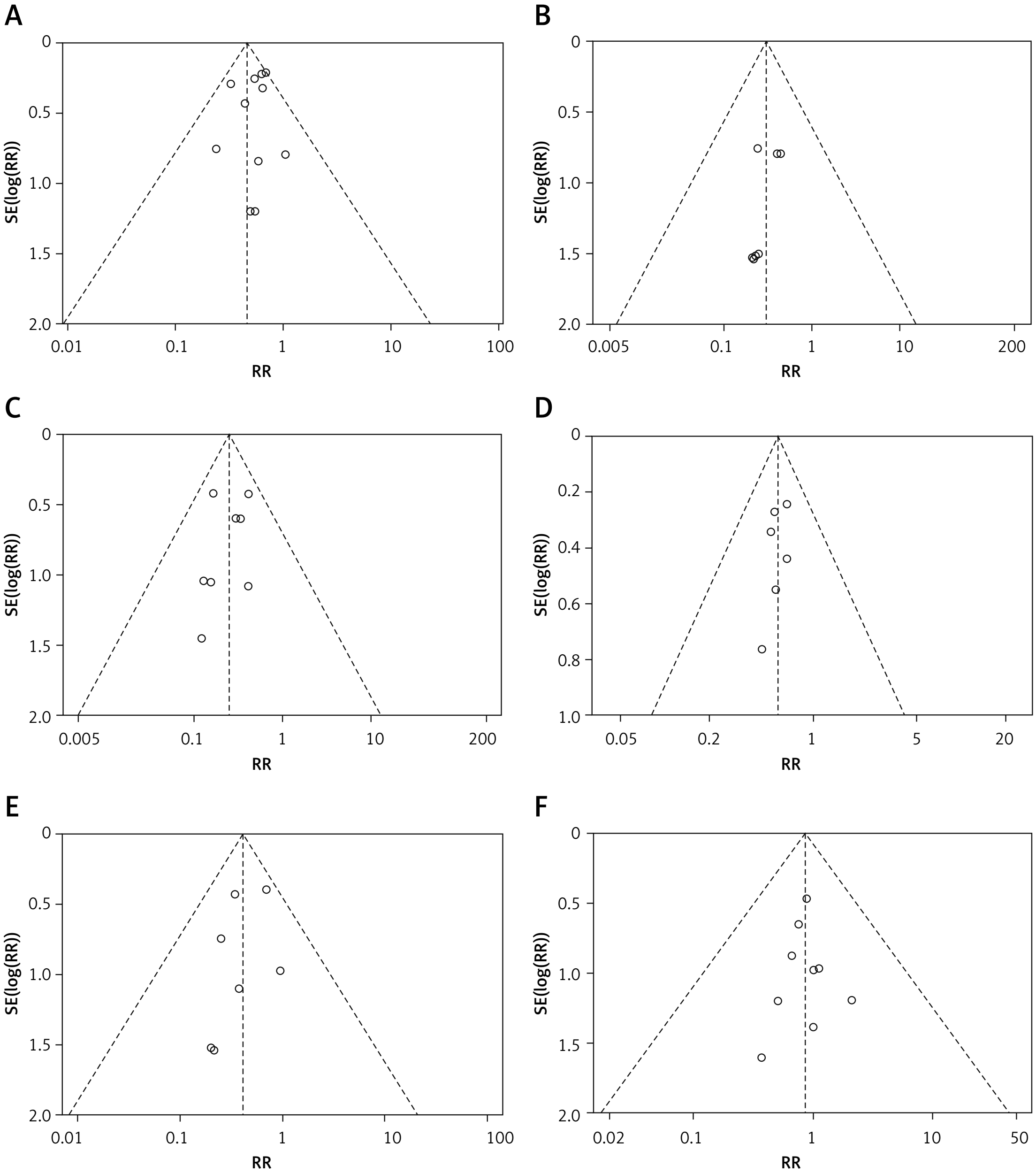

Figure 6. Funnel plots for synthesized outcomes: **A** – Forest plot for the incidence of pneumonia, **B** – Forest plot for the incidence of aspiration, **C** – Forest plot for the incidence of reflux esophagitis, **D** – Forest plot for the incidence of diarrhea, **E** – Forest plot for the incidence of abdominal distension, **F** – Forest plot for the mortality

RCT has reported the blinding of outcome assessment. Therefore, large samples and multi-center RCTs in the future are needed to further evaluate the role of gastric and duodenal feeding in enteral nutrition, to provide reliable evidence for the clinical management and nursing care of TBI.

In conclusion, this present meta-analysis has found that compared with gastric feeding, duodenal feeding is more beneficial to reduce the incidence of pneumonia, aspiration, reflux esophagitis, abdominal distension and diarrhea, and no difference in effect on mortality was found. However, at present, the naso-intestinal tube is less used in clinical practice, the main reason being that the success rate of naso-intestinal tube placement is much lower than that of the gastric tube [52]. Exploration should be strengthened and the insertion success of the naso-intestinal tube should be improved.

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Conflict of interest

The authors declare no conflict of interest.

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