Research Article

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Effect of early enteral nutrition support on nitrogen balance and NIHSS score in elderly patients with acute cerebral stroke and dysphagia

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Abstract: The aim of this study was to evaluate the clinical efficacy of early enteral nutrition support (EENS) on nitrogen balance and National Institute of Health stroke scale (NIHSS) in elderly patients with acute cerebral stroke and dysphagia. Sixty-eight patients diagnosed with acute brain stroke (ABS) were retrospectively analyzed in our hospital database. Of the included 68 ABS subjects, 37 patients were given early EENS within 72h after ABS diagnosis (experiment group) and the other 31 cases were given a regular liquid diet (control group). The nitrogen balance 1, 2, 3 and 4 weeks after EENS were -4.3 ± 1.3 , -3.4 ± 1.1 , -2.6 ± 1.2 and -2.0 ± 1.1 (g/d) respectively for the experiment group and -8.5 ± 3.1 , -7.0 ± 2.4 , -6.2 ± 1.5 and -5.7 ± 1.1 (g/d) respectively for the control group. This indicated that the nitrogen balance in the experimental group was significantly higher than that of the control group ($p < 0.05$). After treatment, the NIHSS score were 7.3 ± 2.3 and 7.4 ± 2.4 in the experimental and control groups respectively with statistically significant difference ($p < 0.05$). The risk of developing regurgitation, diarrhea and ventosity in the experimental group were significantly lower than that of the control group ($p < 0.05$). EENS can quickly improve the burden of ABS in elderly patients, elevate the nutritional level and reduce the risk of related complications.

Keywords: early enteral nutrition support; acute stroke; elderly; dysphagia; nitrogen balance; nutritional status.

Introduction

Acute brain stroke (ABS) is one of the most common acute cerebrovascular diseases [1]. The onset of ABS is abrupt and the main clinical manifestations include hemiparesis, language disturbance and visual impairment. All of the above clinical manifestations are mostly associated with injuries to the central nervous system (CNS). Some studies also demonstrated that about 1/4 to 1/2 of all ABS patients experience dysphagia [2, 3]. Moreover, the oropharyngeal muscles and epiglottis of ABS patients may decline functionally due to CNS damage [4]. This dysfunction can negatively impact patients' ability to swallow which affects their normal food intake and may even cause aspiration pneumonia. Moreover, geriatric ABS patients are more prone to malnutrition, aspiration pneumonia and other complications due to the decline in bodily functions and increased catabolism [4-6]. Therefore, improving the nutritional status of elderly patients with acute cerebral stroke and dysphagia is important for a positive prognosis. In this study, the author aimed to explore the influence of early EENS on the nitrogen balance and prognosis of elderly ABS patients with dysphagia.

Materials and methods

Patients selection

Sixty-eight patients diagnosed with ABS were retrospectively analyzed in our hospital database. Of the included 68 ABS subjects, 37 patients were given early EENS within 72 h after ABS diagnosis (experimental group) and the other 31 cases were given regular liquid diet (control group). The patients' inclusion criteria were four-fold: (1) age ≥ 70 years old; (2) acute brain stroke was confirmed by brain CT or MRI (**Figure 1**); (3) the onset time was less than 72 h and (4) dysphagia was diagnosed by standardized swallowing assessment (SSA) [7] (Supplement table 1).

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Informed consent

Informed consent was obtained from all individuals included in this study.

Ethical approval

The study relevant to human use has been complied with all the relevant national regulations, institutional policies and in accordance with the tenets of the Helsinki Declaration and has been approved by the institutional review board or equivalent committee of Dongguan branch of Yanan University Affiliated Hospital.

Early enteral nutrition administration

Sixty-eight patients with swallowing dysfunction had indwelling nasogastric tubes inserted within 72 hours of admission. The control group was fed with a conventional liquid diet (e.g. homemade rice soup, milk and fish soup). Patients in the experimental group were given early EENS through nasogastric tubes. The EENS formulation was: protein (20 g), maltose (60 g), fructo-oligosaccharide (60 g), starch (60 g), refined corn oil (20 g), trace elements (sodium (500 mg), potassium (750 mg), chlorine (625 mg), calcium (400 mg), phosphorus (360 mg), magnesium (100 mg) and iron (8 mg)), vitamins (vitamin A (400 µg), vitamin D (3 µg), vitamin E (6 mg), vitamin K (25 mg) and vitamin B (30 mg)). The patients were given 500 mL enteral nutrition administration 6 times per day through nasogastric tubes for the first few days. This was then gradually increased to 1500 mL per day.

Observational index

(1) Nitrogen balance: The nitrogen balance of the patients was calculated after they were given EENS for 1-4 weeks. The formula was as follows: Nitrogen balance (g/d) = nitrogen intake (g/d) – (24 hr urine urea nitrogen +4) [8]; (2) Serum albumin: Routine blood tests were conducted once a week to compare the serum albumin level between the two groups; (3) NIHSS scores [9]: A record of the NIHSS scores from when the patients were initially hospitalized to after they had received treatment for 4 weeks was kept and then comparisons were made; (4) Complications: A record of the patients' complications during their hospital stay was maintained and included aspiration pneumonia, pulmonary infection, diarrhea, abdominal distension and alimentary tract hemorrhage.

Statistical analysis

Measurement data was expressed as the mean ± standard deviation and by student-t tests between groups. The enumeration data were expressed as a relative number and the comparison between groups were made based on the χ^2 test Two tailed. $p < 0.05$ was considered statistically significant. All the data analysis was performed by stata11.0 software.

Results

General characteristics of the two groups

The main characteristics of patients in the experimental and control groups are demonstrated in **Table 1**. There were no statistical differences in the aspects of age, gender, stroke type or NIHSS score.

Nitrogen balance comparison of the two groups

The nitrogen balance of the experimental group at each time point (1, 2, 3 and 4 weeks) after enteral nutrition administration were -4.3 ± 1.3 , -3.4 ± 1.1 , -2.6 ± 1.2 and -2.0 ± 1.1 (g/d), respectively. For the control group, at 1, 2, 3 and 4 weeks after hospitalization the nitrogen balance was -8.5 ± 3.1 , -7.0 ± 2.4 , -6.2 ± 1.5 and -5.7 ± 1.1 (g/d), respectively. The nitrogen balance in the experimental group was significantly higher ($p < 0.05$) than that of the control group (**Figure 1**).

Table 1: The general characteristics of patients in the two groups.

Characteristic	Control (n=31)	Experimental (n=37)
Age (year)	72.1 ± 13.6	73.6 ± 12.1
Gender [n(%)]		
Male	17 (54.8)	22 (59.5)
Female	14 (45.2)	15 (40.5)
Stroke type [n(%)]		
Ischemic	18 (58.1)	23 (62.2)
Hemorrhagic	13 (41.9)	14 (37.8)
NIHSS score	14.9±3.3	15.3±3.2

Figure 1: Magnetic Resonance Imaging (MRI) of patients with acute cerebral stroke and dysphagia (A & B: 66 year old male patient with brainstem infarction; C & D: 74 year old female patient with brainstem infarction; E & F: 71 year old female patient with brainstem infarction; G & H: acute brainstem infarction of a 68 years old male patient). The MRI-recording modalities were A: apparent diffusion coefficients (ADC); B: fluid attenuated inversion recovery (FLAIR); C, E, G: T2 weighted image (T2WI); D, F, H: diffusion weighted image, (DWI).

Serum albumin comparison

The serum albumin levels of the two groups at different time points are shown in Table 2. The serum albumin levels of the experimental group was significantly higher ($p<0.05$) at 2, 3 and 4 weeks after enteral nutrition administration than those of control group.

NIHSS score comparison

The NIHSS score was evaluated 4 weeks after EENS. NIHSS scores for the experimental and control groups were 7.3 ± 2.3 and 7.4 ± 2.4 respectively. The NIHSS score of the experimental group was significant lower than that of the control group with statistical difference ($p<0.05$) (Table 3).

Complication comparison

The risks of developing regurgitation, diarrhea and ventosity in the experimental group were significantly lower than that of control group ($P<0.05$). However, there were no statistical difference for the risks of developing pulmonary infection, urinary tract infection and hemorrhage of the digestive tract between the two groups ($p>0.05$) (Table 4).

Table 2: Comparison of serum albumin levels at different time points.

Group	Week 0	Week 1	Week 2	Week 3	Week 4
Control (n=31)	37.2±2.4	35.3±2.0	28.6±1.9	27.7±2.1	28.4±1.8
Experimental (n=37)	38.0±2.2	35.1±2.4	34.2±2.1*	35.1±1.9*	36.2±1.7*

Table 3: Comparison of NIHSS scores between the two groups after 4 weeks of treatment.

Group	n	Pre-treatment	Post-treatment
Control	31	14.2±3.7	7.4±2.4*
Experimental	37	14.5±3.9	7.3±2.3*

* $p<0.05$, compared with control group

Discussion

The incidence of dysphagia is high in ABS patients and clinical epidemiological studies demonstrated that about 50% of cerebral infarction or cerebral hemorrhage patients have different degrees of swallowing dysfunction [10, 11]. ABS occurs when a patients’ medulla oblongata is injured due to ischemia or infarction which directly affects the function of their oropharyngeal muscle and

Table 4: Comparison of complications within the two groups during the treatment [n (%)].

Complication	Control(n=31)	Experimental (n=37)
Regurgitation	7 (22.6)	2 (5.4) *
Pulmonary infection	3 (9.7)	3 (8.1)
Urinary tract infection	2 (6.5)	1 (2.7)
Diarrhea	11 (35.5)	3 (8.1) *
Ventosity	15 (48.4)	5 (13.5) *
Haemorrhage of digestive tract	3 (9.7)	2 (5.4)

*p<0.05, compared with control group

Figure 2: The Nitrogen balance comparison of the two groups.

results in swallowing disorders. Moreover, some patients' swallowing disorders are probably caused by injuries in the cerebral cortex, the area of the brain responsible for bodily coordination [12, 13].

Geriatric patients have fast rates of catabolism and slow anabolism; moreover, their bodily functions deteriorate with advancing age. These factors may contribute to the development of a negative nitrogen balance [14]. ABS usually causes a systemic stress response and increases the secretion of glucagon and glucocorticoids; this accelerates protein, fat and amino acid catabolism and also reduces the body's nutrient stores. Low nutritional levels may result in weakened immunity, thereby increasing the risk of pulmonary infection, urinary tract infection and other diseases. Patients with ABS are in a highly metabolic state resulting in an increased rate of protein breakdown compared to synthesis which leads to a situation where there is a negative nitrogen balance. Without enough energy and nutritional support this negative nitrogen balance will, in time, affect the formation of serum albumin, decrease immune function and even seriously affect the recovery of the patient's neurological function. The energy consumption and rate of catabolism of patients

with ABS was increased. The main function of nutritional support was to provide nutritional substrate for patients, change the body's metabolic state and participate in the organ function recovery. Therefore, patients with swallowing dysfunction should be given nasogastric EENS at the earliest time to correct the negative nitrogen balance, improve the nutritional state and reduce the risk of ABS related complications [15-17]. Xu Xiaolin et al., [18] investigated the influence of EENS on the prognosis of ABS patients with dysphagia. In their study, the authors selected 82 patients with half of the patients receiving EENS and the other half receiving a conventional liquid diet. Xu Xiaolin et al., then made a comparison of the nutritional status and complications between the two groups 4 weeks later. The results showed that the experimental group's nutritional status was significantly better than that of the control group. The incidence of ABS related complications (e.g., aspiration pneumonia and bedsores) in the experimental group was significantly lower compared to the control group. These results proved that EENS for ABS patients with dysphagia could improve their state of nutrition and prognosis. However, reports on the influence of EENS on the nutritional status and prognosis of geriatric ABS patients with dysphagia have seldom been reported in the literature. In our present study, we selected ABS patients over the age of 70 years old and fed them through indwelling nasogastric tubes, within 72 hours of admission. The results showed that the nitrogen balance in the experimental group was significantly higher compared with that in the control group on the first week of intervention. On the second week, the serum albumin levels of the experimental group was significantly higher than that in the control group, indicating that EENS could rapidly improve geriatric ABS patients' nutritional state and correct their negative nitrogen balance.

EENS is not only a nutritional support, but also plays an irreplaceable role in protecting intestinal mucosal barrier. EENS can maintain the stability of the visceral blood flow and the integrity of the gastrointestinal mucosa. It can stimulate the gastrointestinal tract, activate the gastrointestinal nerve endocrine immune axis, promote the secretion of intestinal hormones, regulate the secretion of the liver, bile duct and pancreas thereby promoting gastrointestinal peristalsis and mucous membrane growth. EENS can also maintain normal intestinal flora, improve immune function, reduce oxidative stress and reduce inflammatory factors in the intestine. In the experiment group, the NIHSS score was significantly lower than those of control group with statistical difference ($p < 0.05$) after 4 weeks. This indicated that EENS can improve neurological

function in patients with ABS. Generally, the oxidative stress was always induced by inflammation in patients with ABS. And the inflammation occurring as a result of cardio-cerebrovascular disease such as acute myocardial infarction, ABS was often assessed by measuring the concentration of plasma and urinary neopterin [19]. Previously studies have demonstrated that the neopterin level can be used as biomarker for oxidative stress and inflammation during in vitro cell culture [20,21]. Serum levels of neopterin has been used as a biomarker for prognosis of patients after acute ischemic stroke. Lin and his colleagues [22] found that serum neopterin levels were substantially higher in patients with severe neurological impairment (NIHSS score ≥ 12) than in those with NIHSS < 12 ($p < 0.05$). Serum neopterin was strongly and independently predictive of 90-day unfavorable clinical outcome in patients after acute ischemic stroke. In our study, the improved neurological function of patients in the experimental group may be attributable to the inhibition of inflammatory reaction caused by EENS.

We also found that the incidence of aspiration pneumonia, pulmonary infection, diarrhea, abdominal distension, and alimentary tract hemorrhage of the experimental group was significantly lower than in the control group. This finding suggests that EENS could significantly reduce the risk of relevant complications. Limitations of the study include a small sample size and short follow-up time. Consequently, the statistical accuracy of the study cannot be fully validated and long-term effects will need further evaluation. In addition, the retrospective study design may lead to patients selection bias which may decrease its clinical evidence validity.

Conclusion

EENS can quickly improve the balance of burden in elderly ABS patients, elevate the nutritional level and reduce the risk of related complications. However, the conclusion should be further confirmed by well designed prospective randomized controlled trials.

Conflict of interest: Authors state no conflict of interest.

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