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Original Article

Relationship between gastric tube retention and swallowing dysfunction in comatose patients undergoing tracheotomy

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Abstract: Objective: To investigate the relationship between gastric tube retention and swallowing dysfunction in comatose patients undergoing tracheotomy. Method: A retrospective study was conducted on 116 patients who underwent tracheotomy at our hospital between January 2023 and March 2025. According to the presence or absence of swallowing dysfunction, patients were divided into a swallowing dysfunction group and a non-swallowing dysfunction group. Baseline characteristics, clinical data, and scale evaluation results of included patients were retrospectively analyzed, and the relationship between gastric tube retention time and swallowing dysfunction was assessed. Univariate and multivariate logistic regression analyses were performed to identify factors influencing swallowing dysfunction. Results: The incidence of swallowing dysfunction in comatose patients undergoing tracheotomy was 24.14%. Correlation analysis demonstrated a strong correlation between the duration of gastric tube retention after tracheotomy and swallowing dysfunction (P<0.05). Univariate analysis indicated that age >75 years, smoking, alcohol consumption, history of aspiration and lung infection, use of anti-infective drugs, gastric tube retention time after tracheotomy, coma duration >1 week, mechanical ventilation duration >1 week, absence of swallowing drainage, ICU-acquired weakness, and nutritional risk score ≥3 points were significantly associated with swallowing dysfunction (*P*<0.05). Multivariate logistic regression analysis identified age >75 years, smoking, alcohol consumption, history of aspiration and pulmonary infection, gastric tube retention duration >4 weeks after tracheotomy, coma duration >1 week, and nutritional risk score ≥3 points as independent risk factors for swallowing dysfunction in comatose tracheotomy patients (all *P*<0.05). Conclusion: Swallowing dysfunction in comatose patients after tracheotomy is associated with the duration of gastric tube retention. Independent risk factors include advanced age, prolonged coma, extended gastric tube retention, and poor nutritional status.

Keywords: Tracheotomy, swallowing function, gastric tube retention, relevance, influencing factors

Introduction

Coma is often caused by severe traumatic brain injury, acute cerebrovascular disease, or central nervous system infections. It can lead to relaxation of the throat muscles, increase the risk of airway obstruction, impair the effectiveness of mechanical ventilation, reduce the ability to clear secretions independently, and increase the risk of pulmonary infection [1, 2]. Tracheostomy establishes an airway channel in the neck, thereby improving airway patency, reducing laryngeal and pharyngeal injury caused by oral or nasal tracheal intubation, facilitating the clearance of tracheal and bronchial secretions, and improving respiratory function [3, 4]. Although this technology can be life-saving and provide conditions for subsequent treatment, it can interfere with the physiological process of swallowing through mechanisms such as incomplete airway closure, weakened pharyngeal sensation, glottal closure dysfunction, and anatomical changes, inducing or exacerbating swallowing dysfunction [5, 6]. Zhang et al. [7] analyzed the effect of tracheostomy tube on swallowing function, showing that the procedure can impair swallowing function and hinder muscle activity during swallowing. Gastric tube placement is also a commonly used life-support technique in critically ill patients. By inserting a

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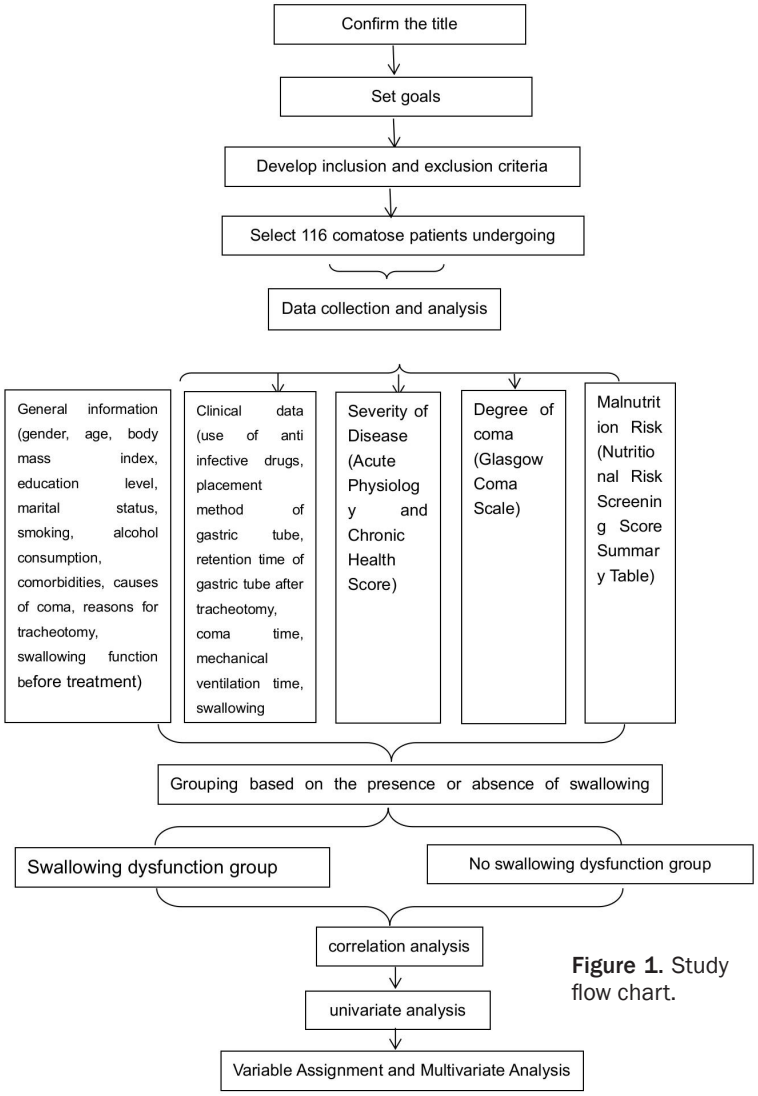

Figure 1. Study flow chart.

flexible tube into the stomach through the oral or nasal cavity, nutritional support can be provided to patients unable to eat orally [8, 9]. However, the presence of the foreign body may produce a space-occupying effect, leading to sensory abnormalities, altering physiological and anatomical structures, and thereby interfering with normal swallowing function [10, 11]. Compared with patients without swallowing dysfunction, those with tracheostomy combined with swallowing dysfunction are more prone to complications such as aspiration pneumonia and pulmonary infection, which can be fatal in severe cases [12]. Based on this background, this study focuses on comatose patients undergoing tracheotomy, analyzing the relationship between gastric tube placement and swallowing dysfunction, and exploring the influencing factors of swallowing dysfunction.

Methods

Sample size estimation and patient inclusion

The sample size was determined according to the method proposed by Hsieh FY [13]. The sample size required for logistic regression to detect a significant predictor is approximately equal to that for testing the mean difference between exposed and unexposed groups, adjusted by a variance factor. The formula used was: $n=\frac{(Z_{1-\alpha/2}+Z_{1-\beta})^2}{P(1-P)\beta^2}$, where P is the proportion of positive outcomes in the samples, set at 24.14%, and β is the regression coefficient, converted to an odds ratio (OR) using OR= eβ. Setting OR=2.02 yields β= ln(2.02)≈0.703; α and 1-β were set at 0.05 and 90%, respectively, corresponding to Z1-α/2=1.96 and Z1-β=1.28, respectively.

Based on these calculations, a retrospective analysis was finally conducted on 116 patients who underwent tracheotomy treatment at our hospital from January 2023 to March 2025. The study protocol was reviewed and approved by the Medical Ethics Committee of Nanchang University Affiliated Rehabilitation Hospital. Due to the retrospective nature, all data were extracted from the hospital's electronic medical record system and clinical databases. Therefore, the requirement for informed consent from patients and their families was waived. Patients were subsequently divided into a swallowing dysfunction group (n=28) and a non-swallowing dysfunction group (n=88) according to the presence or absence of swallowing dysfunction. The flow chart of patient inclusion are shown in **Figure 1**.

Diagnostic criteria for swallowing dysfunction

The swallowing function was evaluated using the Standardized Swallowing Assessment (SSA) [16]. The intra-group and inter-group correla-

Table 1. Glasgow coma scale score

Project/Score	1 point	2 points	3 points	4 points	5 points	6 points
Eye opening	No response	To painful stimuli	To verbal commands	Spontaneous		
Verbal response	No response	Incomprehensible sound	Single words, without logical connection	Converses, with confusion	Oriented	Appropriate and coherent speech
Motor response	No response to pain	Decerebrate response to pain	Decerebrate response to pain	Decerebrate response to pain	Decerebrate response to pain	Decerebrate response to pain

tion coefficients were 0.85 and 0.82, respectively. X-ray fluoroscopy served as the gold standard for swallowing function examination, with a sensitivity of 77.8% and specificity of 68.1%.

Before administering food or water, a clinical examination was conducted to assess consciousness, head and trunk control, breathing pattern, lip closure, soft palate movement, laryngeal function, and pharyngeal reflex. The scores ranges from 8 to 23. After evaluation, patients were instructed to swallow 5 mL of warm water three times, observing throat movement, repeated swallowing, and wheezing during swallowing. These activities were scored, ranging from 5 to 11. If no abnormalities were observed in the above evaluations, patients were instructed to swallow 60 mL of water, recording drinking time and observing for coughing. Scores range from 5 to 12. The total SSA score ranges from 18 to 46 points. A final score ≥18 points (sum of the lowest scores of each item) indicates the presence of swallowing dysfunction.

Inclusion and exclusion criteria

Inclusion criteria: (1) Comatose patients who underwent tracheotomy; (2) Placement of a nasogastric or orogastric using a specialized gastric tube holder for nutritional support; (3) Age >18 years; (4) Complete clinical information; (5) Stable condition; (6) Receipt of standardized clinical treatments and nursing during hospitalization time.

Exclusion criteria: (1) Conscious patients; (2) Patients with unstable vital signs; (3) Patients receiving alternative ventilation methods (e.g., tracheal intubation); (4) Patients with pre-existing swallowing dysfunction before gastric tube placement.

Data collection

(1) General Information: A general information survey form was created, collecting data on sex, age, body mass index (BMI), education level, marital status, smoking and alcohol consumption, comorbidities, history of aspiration, and previous infection.

(2) Clinical data: Clinical data were collected from the hospital information management system, including cause of coma, use of anti-infective drugs, tube placement method, retention time, swallowing function before treatment, coma duration, mechanical ventilation duration, presence of swallowing drainage, and ICU acquired complications.

(3) Disease severity: The severity of disease was evaluated using the Acute Physiology and Chronic Health Evaluation (APACHE) score [14], consisting of acute physiology score, chronic health score, and age. Total scores range from 0-71 points, with <10 points indicating mild disease and favorable prognosis.

(4) Glasgow Coma Scale (GCS) score (**Table 1**): The scale assesses eye opening (1-4 points), verbal response (1-5 points), and motor response (1-6 points), with a total score ranging from 3 to 15. A score ≤8 indicates the need for endotracheal intubation [15].

(5) Nutritional risk score (**Table 2**): This scale evaluates disease severity, impaired nutritional status, and age, with scores ranging from 0 to 7. A total score <3 indicates no nutritional risk.

Statistical methods

Statistical analysis was performed using SPSS 28.0. Continuous variables were tested for normality using the Kolmogorov-Smirnov test and presented as mean ± standard deviation (SD). Group comparisons were conducted using t-tests. Categorical variables were expressed as numbers and percentages (n, %) and compared using chi square test. A P value <0.05 was considered statistically significant.

The correlation between swallowing dysfunction and gastric tube retention time was ana-

Table 2. Nutritional risk score

Project/Score	0 points	1 point	2 points	3 points
Severity of illness	Mild illness	Patients with chronic diseases who can eat normally, e.g., fractures	Chronic patients requiring bed rest, e.g., major abdominal surgery	Critically ill patients, e.g., ICU patients
Impaired nutritional status	Normal nutrition	Weight loss >5% within 3 months or food intake reduced to 50%-75% in past week	Weight loss >5% within 2 months; Or 18.5 kg/m^2 ≤BMI≤20.5 kg/m^2; Or intake reduced to 25%-50%	Weight loss >5% within 1 month; or BMI<18.5 kg/m^2; or intake <25%
Age adjusted rating	<70 years	≥70 years		

Table 3. General information of included patients [n (%)]

Indicator	Number of cases	%
Sex		
Male	68	58.62
Female	48	41.38
Age (years)		
≤75	76	65.51
>75	40	34.49
Body mass index (kg/m^2)		
<18.5	21	18.10
≥18.5	95	81.90
Educational level		
Junior high school and below	50	43.10
Junior high school diploma or above	66	56.90
Marital status		
Married	93	78.45
No spouse	25	21.55
Smoking	31	26.72
Alcohol consumption	37	31.90
Comorbidity		
Diabetes	15	12.93
Hypertension	12	10.34
Coronary heart disease	8	6.90
Cause of coma		
Neurological disorders	62	53.45
Metabolic disorders or poisoning	40	34.48
Others	14	12.07
Indications for tracheotomy		
Upper airway obstruction	52	44.83
Long-term mechanical ventilation	36	31.03
Loss of airway protection function	22	18.97
Others	6	5.17

lyzed using a two-column correlation coefficient. ($\tau<0$: negative correlation; $\tau=0$: no correlation; $\tau>0$: positive correlation). Correlation strength was defined as: $0\leq|\tau|<0.2$ corresponded to no or very weak correlation; $0.2\leq|\tau|<0.4$ corresponded to weak correlation; $0.4\leq|\tau|<0.6$ corresponded to moderate correlation; $0.6\leq|\tau|<0.8$ corresponded to strong correlation; $0.8\leq|\tau|\leq1.0$ corresponded to very strong correlation.

Binary variables with statistical differences in univariate analysis were included as independent variables in a multivariate logistic regression model to identify independent risk factors for swallowing dysfunction in comatose patients undergoing tracheostomy. The goodness-of-fit of the logistic regression model was evaluated using the Hosmer-Lemeshow test, with $P>0.05$ indicating adequate model fit.

Results

General information

Among the 116 patients, 28 patients (24.14%) experienced swallowing dysfunction, and the other 88 patients (75.86%) didn't. The demographic and clinical characteristics of the included patients, including sex, age, BMI, educational level, smoking and alcohol consumption, comorbidities, causes of coma, and indications for tracheotomy are summarized in **Table 3**.

Correlation analysis

The swallowing dysfunction group had a significantly longer gastric tube retention time compared with the non-swallowing dysfunction group ($P<0.05$; **Table 4**). Two-column correla-

Table 4. Comparison of gastric tube retention time after tracheotomy between the two groups ($\bar{x}\pm s$, weeks)

	Number of cases	Retention time of gastric tube after tracheotomy
Swallowing dysfunction group	28	6.78±1.32
Non-swallowing dysfunction group	88	4.48±1.21
Z		8.570
P		<0.001

tion coefficient analysis showed a strong positive correlation between gastric tube retention time and swallowing dysfunction (r=0.626, *P*<0.05).

Univariate analysis

No significant differences were observed between the two groups in terms of gender, BMI, per capita monthly income, comorbidities, educational level, marital status, indications for tracheotomy, disease severity, GCS score, or pre-treatment swallowing function (all *P*>0.05). Compared with the non-swallowing dysfunction group, the swallowing dysfunction group had significantly higher proportions of patients with age >75 years, smoking and alcohol consumption, previous aspiration and pulmonary infection, gastric tube retention duration >4 weeks, coma duration >1 week, mechanical ventilation duration >1 week, absence of swallowing drainage, nutritional risk score ≥3 points, and ICU-acquired complications (all *P*<0.05; **Table 5**).

Multivariate analysis

Binary variables with statistical differences in univariate analysis were included as independent variables, with swallowing dysfunction as the dependent variable (0 = protective factor, 1 = risk factor; **Table 6**). Due to the relatively small sample size and the presence of 11 potential risk factors, LASSO regression analysis was used for dimensionality reduction. The optimal penalty coefficient λ was determined using regularization, and λ_max was selected to ultimately retain seven variables: age, smoking, alcohol consumption, history of aspiration and infection, gastric tube retention time, coma duration, and nutritional risk score. Multivariate logistic regression analysis identified the following independent risk factors for swallowing dysfunction in coma patients undergoing tracheostomy: age >75 years, smoking, alcohol consumption, history of aspiration and infection, gastric tube retention duration >4 weeks, coma duration >1 week, and nutritional risk score ≥3 points (all *P*<0.05) (**Table 7**). The Hosmer-Lemeshow test showed good model fit (*P*=0.716), confirming satisfactory predictive performance of the model.

Discussion

Tracheotomy is a surgical procedure that involves creating an opening in the neck and the inserting a tracheal tube to establish a respiratory pathway. It is indicated for patients with upper respiratory tract obstruction, those requiring long-term mechanical ventilation, and for airway secretion management [17, 18]. Although this procedure is life-saving for critically ill patients, it can limit the upward movement of the larynx, reduce the pressure-mediated protective effect of the trachea on the esophagus, impede food passage, and impair swallowing function. In addition, tracheotomy can disrupt the coordination between swallowing and breathing, causing aspiration during swallowing and thereby inducing or exacerbating dysphagia [19, 20]. Dysphagia is a clinical syndrome with multifactorial causes, which can lead to symptoms such as food stuttering, painful swallowing, and prolonged eating time. If not treated in a timely manner, it can lead to aspiration, malnutrition, and reduced quality of life [21, 22]. In this study, the incidence of swallowing dysfunction in patients with tracheotomy coma is 24.14% (28/116), comparable to 20.39% (241/1182) reported by Zhang et al. [23].

Clinically, tracheotomy is often combined with gastric tube placement to improve respiratory status and provide nutritional support. However, prolonged retention of a gastric tube can occupy the pharyngeal space, hinder epiglottic closure, restrict upward and forward laryngeal movement, reduce flexibility during swallowing, compress the piriform recess, and damage

Table 5. Single factor analysis of swallowing dysfunction in tracheostomy patients [n (%)]

Factor	Swallowing dysfunction group (n=28)	Non-swallowing dysfunction group (n=88)	χ^2/t	*P*
Gender				
Male	16 (57.14)	52 (59.09)	0.033	0.855
Female	12 (42.86)	36 (40.91)		
Age (years)				
≤75	10 (35.71)	66 (75.00)	14.511	<0.001
>75	18 (64.29)	22 (25.00)		
Body mass index (kg/m^2)				
<18.5	6 (21.43)	15 (17.05)	0.275	0.600
≥18.5	22 (78.57)	73 (82.95)		
Per capita monthly income (yuan)				
<4,000	20 (71.43)	56 (63.64)	0.571	0.450
≥4,000	8 (28.57)	32 (36.36)		
Educational level				
Junior high school and below	11 (39.29)	39 (44.32)	0.219	0.640
Junior high school diploma or above	17 (60.71)	49 (54.68)		
Marital status				
Married	23 (82.14)	70 (79.55)	0.090	0.764
No-spouse	5 (17.86)	18 (20.45)		
Smoking				
Yes	15 (53.57)	16 (18.18)	13.585	<0.001
No	13 (46.43)	72 (81.82		
Alcohol consumption				
Yes	17 (60.71)	20 (22.73)	14.110	<0.001
No	11 (39.29)	68 (77.27)		
Comorbidity				
Have	10 (35.71)	25 (28.41)	0.538	0.463
None	18 (64.29)	63 (71.59)		
Previous aspiration and infection				
Yes	12 (42.86)	10 (11.36)	13.709	<0.001
No	16 (57.14)	78 (88.64)		
Indications for tracheotomy				
Upper airway obstruction	12 (42.86)	40 (45.45)		
Long-term mechanical ventilation	9 (32.14)	27 (30.68)	0.348	0.951
Loss of airway protection function	5 (17.86)	17 (19.32)		
Others	2 (7.14)	4 (4.55)		
Swallowing function before treatment (SSA score)	10.12±2.18	9.96±2.44	0.310	0.757
Normal	24 (85.71)	78 (88.64)	0.526	0.468
Abnormal	4 (14.29)	10 (11.36)		
Disease severity score (points)				
<10	19 (67.86)	66 (75.00)	0,553	0.457
≥10	9 (32.14)	22 (25.00)		
Use of anti-infective drugs				
Yes	13 (46.43)	20 (22.73)	5.862	0.015
No	15 (52.57)	68 (77.27)		
Gastric tube placement method				
Nasogastric tube	18 (64.29)	65 (73.86)	0.957	0.328
Oral gastric tube	10 (35.71)	23 (26.14)		
Retention time of gastric tube after tracheotomy (weeks)	6.78±1.32	4.48±1.21	8.570	<0.001
Glasgow Coma Scale score (points)				
≤5	9 (32.14)	25 (28.41)	0.143	0.705
>5	19 (67.86)	63 (71.59)		
Coma duration (weeks)				
≤1	18 (64.29)	83 (94.32)	14.454	<0.001
>1	10 (35.71)	5 (5.68)		

Mechanical ventilation duration (weeks)				
≤1	7 (25.00)	48 (54.55)	7.437	0.006
>1	21 (75.00)	40 (45.45)		
Swallowing drainage				
Have	18 (64.29)	80 (90.91)	9.544	0.002
None	10 (35.71)	8 (9.09)		
ICU-acquired complications				
Yes	11 (39.29)	14 (15.91)	6.866	0.009
No	17 (60.71)	74 (84.09)		
Nutritional risk score (points)				
<3	18 (64.29)	82 (90.91)	12.585	0.003
≥3	10 (35.71)	6 (9.09)		

Table 6. Variable assignment

Variable	Assignment
Age (years)	≤75=0; >75=1
Smoking	No=0; yes=1
Alcohol consumption	No=0; yes=1
Previous aspiration and infection	No=0; yes=1
Use of anti-infective drugs	No=0; yes=1
Retention time of gastric tube after tracheotomy (weeks)	≤4=0; >4=1
Coma duration (weeks)	≤1=0; >1=1
Mechanical ventilation duration (weeks)	≤1=0; >1=1
Swallowing drainage	have=0; none=1
ICU-acquired complications	No=0; yes=1
Nutritional risk score (points)	<3=0; ≥3=1

Table 7. Multivariate logistic regression analysis

Factor	β value	*SE*	Wald	OR	95% CI	*P*
Age >75 years	0.889	0.354	6.300	2.432	1.215-4.868	0.012
Smoking	1.214	0.418	8.435	1.825	1.172-4.115	0.007
Alcohol consumption	1.378	0.380	13.150	1.916	1.148-3.890	<0.001
Previous aspiration and infection	1.354	0.396	11.691	1.798	1.145-3.765	0.002
Gastric tube retention time after tracheotomy >4 weeks	1.232	0.415	8.813	2.030	1.246-4.780	0.006
Coma duration >1 week	1.392	0.368	14.308	2.078	1.168-3.945	<0.001
Nutritional risk score ≥3 points	1.196	0.421	8.706	1.798	1.121-3.468	0.007

mucosal tissue, further obstructing the passage of food [24].

Our study showed that gastric tube retention time was significantly longer in the swallowing dysfunction group than the non-dysfunction group. Further two-column correlation coefficient demonstrated a strong positive correlation between gastric tube retention time and swallowing dysfunction, indicating that longer retention time increased the risk of swallowing dysfunction in comatose patients undergoing tracheostomy. Prolonged gastric tube retention may impair normal food passage, reduce the coordination of swallowing muscles, decrease pharyngeal mucosal sensitivity to food, and contribute to swallowing dysfunction. In addition, the presence of a gastric tube limits oral intake, leading to muscle atrophy and decreased swallowing coordination, which also confirms the observed correlation between gastric tube retention time and swallowing function.

This study further analyzed the influencing factors of swallowing dysfunction in coma patients undergoing tracheostomy using univariate and multivariate logistic regression. The results showed that age >75 years, smoking, alcohol

consumption, previous aspiration and infection, gastric tube retention time after tracheotomy, coma duration >1 week, and a nutritional risk score ≥3 were independent risk factors for swallowing dysfunction.

Aging is associated with physiological changes in swallowing function, leading to reduced swallowing system efficiency. Compared with younger patients, those over 75 years old may experience decreased sensitivity and muscle strength in the oral and pharyngeal regions, delayed swallowing reflex, and alter esophageal function. Therefore, food may remain in the oral or pharyngeal cavities, or enter the airway before the swallowing reflex is activated, contributing to dysphagia [25, 26]. Xiao et al. [27] reported that older age was an independent risk factor (OR=4.346, 95% CI: 1.261-1.762, P=0.008) for swallowing dysfunction in patients with head and neck malignancies after radiotherapy. similarly, Wang et al. [28] observed that older age independently increased the risk of dysphagia in elderly patients with mild cognitive impairment, consistent with our findings.

Harmful substances in tobacco, such as tar, nicotine, and nitric oxide, can damage the oral and esophageal mucosa, impair mucosal sensory function, delay the swallowing reflex, and inhibit saliva secretion. These effects compromise the formation of food bolus and the coordination of swallowing muscles. Moreover, smoking relaxes of the lower esophageal sphincter and promotes gastric acid reflux, further damaging the throat and esophageal mucosal tissue to induce or worsen mucosal ulcers and increase the risk of swallowing dysfunction. Yang et al. [29] showed that smoking was a contributing factor to the occurrence of swallowing dysfunction in nasopharyngeal carcinoma patients undergoing radiotherapy and chemotherapy (OR=26.000, 95% CI: 2.897-233.351, P=0.004), which is consistent our findings.

Alcohol and its metabolites can directly damage swallowing-related muscles, leading to atrophy, reduced propulsion, and residual food. Chronic and excessive alcohol consumption can cause peripheral neuropathy, disrupt neuromuscular coordination, relax the lower esophageal sphincter, and impair esophageal peristalsis, all of which contribute to swallowing dysfunction. A study conducted by Liu et al. [30] confirmed that a history of alcohol consumption was an independent risk factors for post-stroke dysphagia in elderly patients.

As a consequence of swallowing dysfunction, a history of aspiration can also cause swallowing dysfunction. Liquid or food entering the throat can trigger the cough reflex, which can stimulate the mucosa, leading to inflammatory reactions or mechanical damage. Individuals with a history of aspiration may have a fear of eating and may experience tension during eating, leading to disrupted swallowing rhythms, decreased muscle coordination, and worsening swallowing dysfunction [31]. Infection may impair neuromuscular coordination, directly affect the swallowing center, or alter swallowing function via inflammatory reactions, ischemia, or viral mechanisms.

Prolonged gastric tube retention can occupy pharyngeal space, compress the throat and esophageal mucosal tissue, and impair laryngeal activity and upper esophageal sphincter function, leading to decreased strength of swallowing-related muscles, loss of coordination. In addition, reduced oral intake and saliva secretion in patients with gastric tube placement Reduced oral intake and saliva secretion, increase oral discomfort, and elevate the risk of swallowing dysfunction.

Comatose patients do not have the consciousness to initiate swallowing. Damage to the swallowing center caused by the primary disease can further impair the ability trigger swallowing reflexes, even upon contact with food. This may result in weakened or complete loss of swallowing reflexes.

Malnutrition does not directly cause swallowing dysfunction, but it reduces energy and protein availability, leading to muscle mass loss, decreased strength, impaired mastication, weak pharyngeal propulsion, and residual food in the pharynx. A meta-analysis by Zhang et al. [32] showed that malnutrition is a risk factor for swallowing disorders in community-dwelling elderly individuals, which is consistent with the results of this study.

Conclusion

Swallowing dysfunction in comatose patients undergoing tracheotomy is closely associated with gastric tube retention time and is influ-

enced by multiple factors. Therefore, preventive measures should be reinforced in clinical practice.

This study is a single-center retrospective study that identified independent risk factors through univariate and multivariate logistic regression, but no external validation was performed. Future research should include multicenter prospective studies to validate the predictive value of these risk factors. Methods such as nomogram-based prediction models or decision tree algorithms could be employed to improve risk assessment and clinical decision-making.

Disclosure of conflict of interest

None.

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