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Clinical application of percutaneous gastrostomy in children with dysphagia after traumatic brain injury

A single-center experience

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Abstract

This study explores the clinical application value of percutaneous endoscopic gastrostomy (PEG) in children with dysphagia after brain injury. Children with dysphagia after brain injury were selected and randomly divided into a treatment group and a control group using a random number table method, with 42 cases in each group. The control group received nutritional support using indwelling nasogastric tube technology, while the treatment group received nutritional support using PEG technology. Both groups received the same tube feeding nutrient solution. At the same time, both groups of patients received comprehensive training methods including oral sensation training, oral exercise training, and physical therapy for swallowing dysfunction. Weight, total serum protein, serum albumin, and hemoglobin of the patients were measured 1 day before treatment and 28 days after treatment, respectively. The degree of dysphagia was evaluated by the water swallow test and the dysphagia disorders survey of each patient 1 day before treatment and 28 days after treatment, respectively. Adverse events such as gastrointestinal bleeding, aspiration pneumonia, and reflux esophagitis were recorded. After 28 days of treatment, both the control group and the PEG group showed an increase in body weight, total serum protein, serum albumin, and hemoglobin compared to before treatment ($P < .05$), and the PEG group showed a more significant increase than the control group ($P < .05$). At the same time, swallowing function improved more significantly in the PEG group ($P < .05$), and the incidence of adverse events was lower compared to the control group ($P < .05$). The comprehensive training method for swallowing disorders combined with enteral PEG nutrition has a definite effect on children with swallowing disorders after traumatic brain injury.

Abbreviations: DDS = dysphagia disorders survey, NG = nasogastric, PEG = percutaneous endoscopic gastrostomy, TBI = traumatic brain injury, WSA = water swallow test.

Keywords: children, dysphagia, percutaneous gastrostomy, traumatic brain injury

1. Introduction

The incidence of traumatic brain injury (TBI) in children can reach 2 ‰ to 3 ‰, which is one of the major causes of disability in children.[1] In recent years, with the improvement of medical technology, the mortality rate of TBI has greatly decreased.[2] However, children often suffer from various degrees of physical structure and function disorders, among which dysphagia is one of the most common functional impairments. Studies have shown that the incidence of dysphagia after TBI is as high as 61%.[3,4] If an effective intervention is not carried out, dysphagia will lead to insufficient nutrition intake, pneumonia by inhalation, asphyxia, and other risks for the child, causing a heavy burden to the child, family, and society.[5]

Nutritional support plays an important role in improving the nutritional status of children with dysphagia after TBI and increasing the survival rate of critically ill patients.[6] Nutritional support includes enteral nutrition and parenteral nutrition. Compared to parenteral nutrition, enteral nutrition can stimulate the secretion of digestive fluids and gastrointestinal hormones, increase visceral blood flow, maintain the integrity of intestinal mucosal cell structure and function, maintain intestinal mucosal barrier function, make metabolism more in line with physiological needs, and reduce the occurrence

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The patients' information collected were approved by the Ethics Committee of Hunan Children's Hospital (Ethics Number: KYSQ2022-149). Their privacy was protected without adding additional risks and financial burdens. Each patient has signed a written informed consent before the study.

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of liver and gallbladder complications.[7,8] In clinical practice, for patients who suffer from dysphagia after brain injury and require nutritional support, a nasogastric (NG) tube is usually placed. Although NG feeding in the gastric tube has the advantage of cost and convenience, it is prone to aspiration and reflux, increasing the risk of complications such as pneumonia due to aspiration and reflux esophagitis. If the pipeline is left in the throat for a long time, it will stimulate the throat and reduce its sensitivity to stimulation, increasing the difficulty of training for swallowing function and prolonging the recovery process of swallowing function.[9,10]

Percutaneous endoscopic gastrostomy (PEG) is a procedure that involves placing a gastric fistula tube through gastroscopy for enteral nutrition or gastrointestinal decompression.[11] There is no need for surgery to perform this procedure. PEG is suitable for patients who cannot eat orally, but who have not lost gastrointestinal function, and who need long-term nutritional support. It has the advantages of simplicity, safety and effectiveness, cost effectiveness, fewer complications, minimal trauma, no need for general anesthesia, simple extubation, and rapid postoperative recovery.[12,13] In recent years, it has gradually been widely used in patients with long-term swallowing disorders.[14] This study aims to explore the application value of endoscopic percutaneous gastrostomy to improve dysphagia in children with TBI.

2. Materials and methods

2.1. General clinical data

A total of 84 children with TBI combined with dysphagia treated at Hunan Children's Hospital from January 2020 to October 2023 were selected and randomly divided into a control group and a treatment group using a random number table method, with 42 cases in each group. The control group received nutritional support using indwelling NG tube technology, while the treatment group received nutritional support using PEG technology. Both groups received the same tube feeding nutrient solution. At the same time, both groups of patients received comprehensive training methods for swallowing dysfunction. This study was approved by Ethics Committee of Hunan Children's Hospital (Ethics Number: KYSQ2022-149). Each patient has signed a written informed consent before the study.

2.2. Inclusion criteria

(1) The patients were diagnosed with TBI by imaging methods; (2) the TBI was in recovery period and the patient's condition is stable; (3) the patients had suffered persistent swallowing disorders (>4 weeks); (4) the patients were aged 6 to 12 years old; and (5) the parents of the patient were informed about the study and agreed to it.

2.3. Exclusion criteria

(1) Patients with severe heart, liver, and kidney damage; (2) patients with abnormal immune system and coagulation function; (3) patients with metabolic and genetic diseases such as diabetes; (4) patients with mental illness; and (5) patients with contraindications to PEG.

2.4. Implementation methods

2.4.1. Comprehensive training methods for dysphagia.

(1) Training in oral sensations: (1) Ice stimulation training and taste stimulation training can improve peripheral sensation transmission, stimulate the center of the swallowing cortex, and improve swallowing function. (2) Pulse sensory stimulation training: Pulse stimulation can activate the bilateral frontal cortex network through oropharyngeal stimulation, restore the pharyngeal reflex, and accelerate swallowing initiation.

(2) Oral exercise training: (1) Oral exercise gymnastics: Practice with the help of a master apprentice or simple tools to strengthen the control, stability, coordination, and strength of the lips, tongue, upper, and lower jaw movements. (2) Lip and chewing muscle strength training: Therapists can use a brush or ice to brush back and forth in the lip and jaw joints for 3 to 5 seconds, each time for <3 seconds. After resting for 2 to 3 seconds, the next session can be performed, stimulating for 1 minute to induce muscle contraction. (3) Passive activity training for tongue muscles: Therapists can use the suction head and balloon of a tongue aspirator to directly pull the tongue and lip muscles for passive movement therapy in all directions. (4) Oral and facial vibration stimulation: Use an improved vibrator to brush the cheeks, tongue, or face inside the mouth, providing deep and shallow sensory stimulation to these areas, and improving the coordination ability of oral and facial movements. The total training time is 60 minutes per session, once a day.

(3) Physical therapy: Electrical Swallowing Neuromuscular Stimulator: The YS1002C swallowing neuromuscular electrical stimulator (Changzhou, Jiangsu, China) is selected, with electrode patches applied to bilateral masseter and hyoid muscle groups, once a day, for 20 minutes each time. It can help to improve the strength and contraction speed of the hamstring and hyoid muscles, help lift the throat, and restore chewing and swallowing functions.

2.5. Nutrition therapy

NG tube treatment: Briefly, the patient sat or sat in a lying position with his head slightly tilted back. A damp cotton swab was used to check and clean the nasal cavity. A gauze was held and a gastric tube was dragged in the left hand, while a vascular clamp was held in the right hand to estimate the length of the inserted tube at the front end, which is approximately 18 to 24 cm. The length was marked with adhesive tape. The gastric tube was lubricated and slowly pushed along one side of the nostril. When the gastric tube reached the pharynx, the patient should make a swallowing motion, and then the gastric tube was continued to push until it reached the stomach. The gastric tube was then fixed with adhesive tape on the nasal wings and cheeks. After 8 hours of operation, enteral nutrition support can be provided to the patient, and isotonic saline solution should be administered for the first tube feeding. Gradually, the nutrition can convert into an enteral nutrition solution 2 to 3 days after the operation. After feeding, the patient's gastric tube should be rinsed with 0.9% physiological saline to avoid blockage of the lumen by residual nutrition solution.

2.6. Percutaneous gastrostomy treatment

The preoperative fasting time should be >6 hours. The patient was advised to take a supine position with his head tilted to the left. PEG was performed using the traction method. After general anesthesia, the endoscope was inserted into the descending segment of the duodenum and the endoscope was retracted to the gastric body with sufficient gas injection. The assistant marked the brightest spot on the upper abdomen and cut a small opening of 0.3 to 0.5 cm. Under endoscopy, the puncture trocar was inserted into the stomach through this incision and the needle core was pulled out and sent into the lead wire. After the foreign body clamp under endoscopy, the lead wire was clamped to the oral cavity together with the endoscope. After connecting the double-stranded wire to the coil at the end of the fistula tube, the

pulling wire pulled the fistula tube into the stomach. When the conical end of the fistula tube was pulled into the trocar, it was pulled out of the abdominal wall together with the trocar until the fixed gastric plate was tightly attached to the gastric wall. After the endoscope entered the designated position, external fixation discs were used to fix the fistula tube, and the tail end was externally connected to the connecting head. Disinfectant gauze was used to cover the incision. The skin around the fistula and the leakage around the fistula were carefully checked. Physiological saline was administered through a fistula tube 24 hours after the operation, and the amount of milk and nutritional supplements gradually increased. The gastric fistula tube should be flushed with clean water before and after each feeding to ensure a smooth passage of the tube.

Both groups received the same tube feeding nutrient solution.

2.7. Observation and evaluation indicators

All patients underwent enteral nutrition and swallowing treatment, and the following indicators were recorded 1 day before treatment and 28 days after treatment.

(1) General situation and indicators of nutritional evaluation: weight, serum total protein, serum albumin, and hemoglobin.
(2) Evaluation of swallowing function: Water swallow test (WSA) and dysphagia disorders survey (DDS).[15,16]
(3) Complications of 2 groups: gastrointestinal bleeding, aspiration pneumonia, and reflux esophagitis.

2.8. Statistical analysis

SPSS 21.0 statistical software was used for data analysis. The measurement data was expressed as mean ± standard deviation and the *t*-test was used for comparison; the count data were expressed using rate, while comparison was done using $\chi 2$. The difference is statistically significant with $P < .05$.

3. Results

3.1. Basic clinical characteristics of the 2 groups of patients

There were 84 patients were included, with 42 in the PEG group and 42 in the control group. The Glasgow Coma Scale was used for TBI grading, and there was no difference in baseline between the 2 groups of patients. In the control group, there were 28 males and 14 females. The average age was (8.68 ± 1.75) years. The causes of injury were 14 cases of fall collision, 20 cases of fall and hurting oneself, and 8 cases of fall from height. The degrees of dysphagia were Grade II in 7 cases, Grade III in 22 cases, Grade IV in 9 cases, and Grade V in 4 cases. In the PEG group, there were 30 males and 12 females. The average age was (8.95 ± 1.88) years old. The causes of injury were 15 cases of fall collision, 21 cases of fall and hurting oneself, and 6 cases of fall from height. The degrees of dysphagia were Grade II in 8 cases, Grade III in 21 cases, Grade IV in 10 cases, and Grade V in 3 cases. There were no statistically significant differences in general information between the 2 groups ($P > .05$), as shown in Table 1. Also, there were no differences in albumin, weight, hemoglobin at baseline between both groups (Fig. S1, Supplemental Digital Content, https://links.lww.com/MD/O724).

Table 1

Comparison of clinical data between the 2 groups of patients.

Characteristics	Control group (n = 42)	PEG group (n = 42)	*P* value
Gender			.814
Male	28	30	
Female	14	12	
Age (years)	8.68 ± 1.75	8.95 ± 1.88	.764
Cause of injury			.915
Falling collision	14	15	
Fall and hurt yourself	20	21	
Falling from height	8	6	
GCS	8.96 ± 1.12	9.01 ± 1.15	.830
Water Swallow Test			.986
II	7	8	
III	22	21	
IV	9	10	
V	4	3	

GCS = Glasgow Coma Scale, PEG = percutaneous endoscopic gastrostomy.

3.2. Comparison of nutritional indicators between 2 groups

Compared to baseline level, weight ($P = .089$), total protein ($P < .05$), albumin ($P < .05$), and hemoglobin ($P < .05$) of the control group increased (Fig. 1A–D). Compared to baseline level, patients in the PEG group also showed significant increases in body weight ($P < .05$), total protein ($P < .05$), albumin ($P < .05$), and hemoglobin ($P < .05$) (Fig. 1E–H). At the same time, the PEG group showed a significant increase in weight ($P < .05$), total protein ($P < .05$), albumin ($P < .05$), and hemoglobin ($P < .05$) compared to the control group after treatment (Fig. 1I–L). These results indicate that PEG was more effective in comprehensively improving the impact status of pediatric patients than nasal feeding.

3.3. Comparison of swallowing function evaluation between 2 groups

Compared to baseline level, the results of the WSA score and the DDS score in the control group showed a significant decrease after treatment ($P < .05$). Compared to baseline level, the results of the WSA score and the dysphagia disorders survey score in the PEG group showed a significant decrease after treatment ($P < .05$).

All these results indicate that comprehensive rehabilitation treatment for dysphagia was effective, and the improvement in the PEG group was more significant, possibly due to better nutritional recovery in the PEG group, which promoted the recovery from dysphagia (Tables 2 and 3).

3.4. Comparison of adverse events between 2 groups

The most common adverse events were gastrointestinal bleeding, aspiration pneumonia, and reflux esophagitis. The incidence of adverse events in the PEG group was lower than in the control group ($P < .05$), indicating that the PEG group had good treatment safety (Table 4).

4. Discussion

Dysphagia is a common complication after TBI in children and is mainly related to damage to the central nervous system.[2,3] If not handled quickly, it can lead to internal environment disorder, inadequate nutrients intake, restricted growth and development, and an increased risk of complications such as aspiration, aspiration pneumonia, and respiratory infections.[5] At the same time, dysphagia is not conducive to the growth and development of neurological function, which affects the effectiveness of rehabilitation treatment for TBI.[17] Therefore, it is extremely important to pay attention to the rehabilitation intervention for dysphagia after TBI.

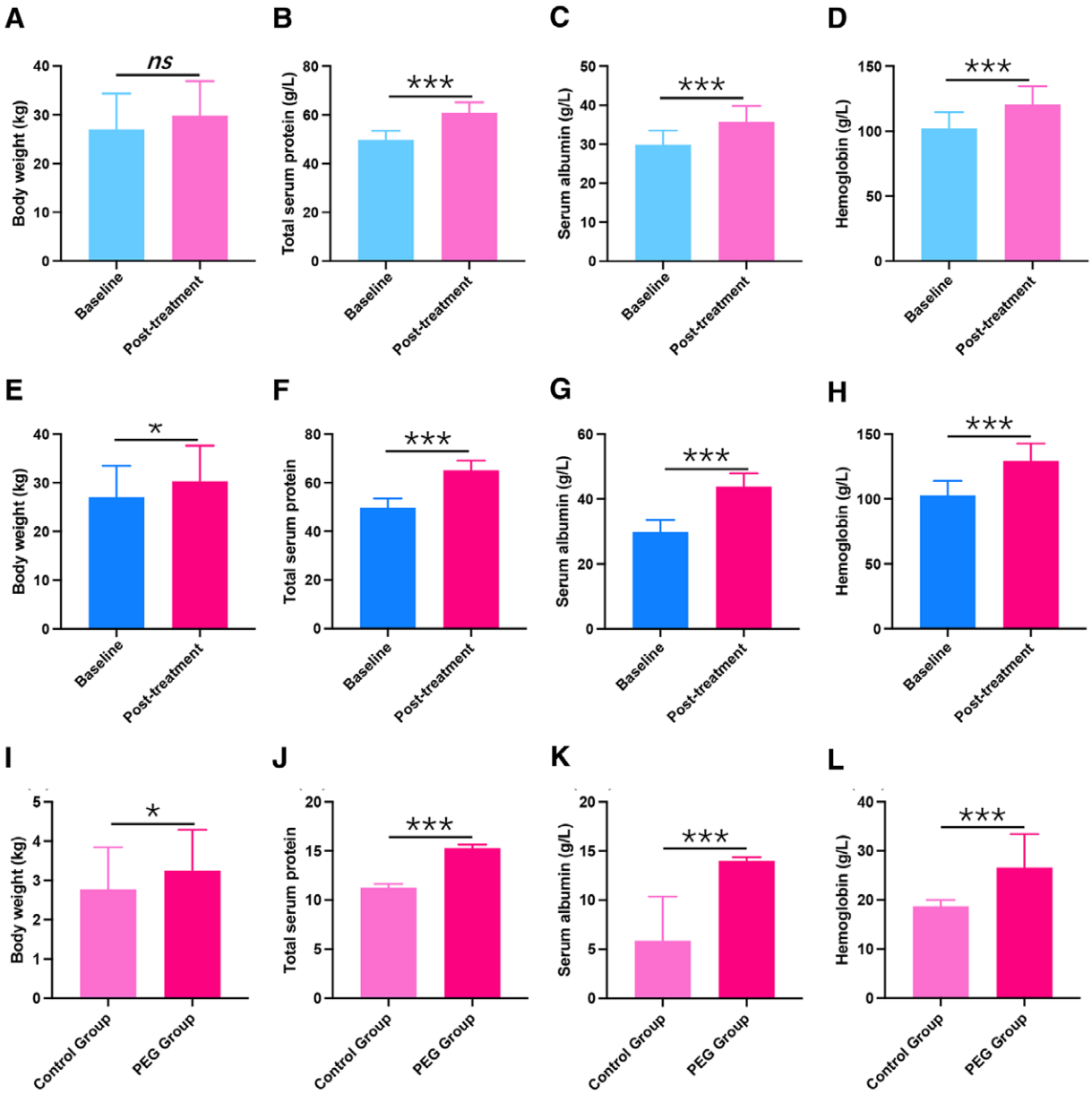

Figure 1. Comparison of nutritional indicators between 2 groups. (A–D) Weight, total protein, albumin, and hemoglobin of the control group before and after treatment. (E–H) Weight, total protein, albumin, and hemoglobin of the PEG group before and after treatment. (I–L) Elevated levels of body weight, total protein, albumin, and hemoglobin before and after treatment in the control group and PEG group. *<0.05, ***<0.005. PEG = percutaneous endoscopic gastrostomy.

Table 2

Comparison of the WSA score between the 2 groups of patients.

	Baseline	Posttreatment	*t* value	*P* value
Control group	3.89 ± 0.54	2.79 ± 0.58	6.931	<.001
PEG group	3.91 ± 0.48	1.83 ± 0.37	12.468	<.001
t value	0.174	9.654		
P value	.879	<.001		

PEG = percutaneous endoscopic gastrostomy, WSA = water swallow test.

Table 3

Comparison of the DDS score between the 2 groups of patients.

	Baseline	Posttreatment	*t* value	*P* value
Control group	12.20 ± 2.03	10.27 ± 1.67	4.039	<.001
PEG group	12.08 ± 2.24	9.14 ± 1.53	5.674	<.001
t value	0.175	2.957		
P value	.796	.003		

DDS = dysphagia disorders survey, PEG = percutaneous endoscopic gastrostomy.

PEG is a highly practical endoscopic treatment operation that not only relieves pressure on the gastrointestinal tract, but also reduces trauma caused by minimally invasive procedures. Compared to enteral nutrition of the NG tube, PEG is more in line with physiological functions and operation, has a wider range of indications, and can reduce complications such as gastro-esophageal reflux, aspiration, and gastric bleeding. It can also reduce repeated intubation or patient irritability and self-removal of the tube, which can affect damage to the pharynx and esophageal mucosa.[18,19]

Table 4

Comparison of adverse events between 2 groups.

	Control group	PEG group	*P* value
Gastrointestinal bleeding	6	0	.026
Aspiration pneumonia	8	1	.030
Reflux esophagitis	9	2	.049

PEG = percutaneous endoscopic gastrostomy.

PEG has been reported to significantly improve the nutritional status of patients, with a lower failure rate and fewer adverse reactions compared to the NG tube. The easy operation characteristics and low complications of PEG are suitable for patients who do not receive oral nutrition for long-term retention. After discharge, enteral nutrition can be performed at home to shorten hospitalization time and reduce medical expenses.[20,21] The incidence of complications in PEG is low, generally manifested as mild complications, including incision infection, catheter displacement, leakage near the fistula site, catheter blockage, and incision hematoma, which can be resolved after treatment.[22,23] At the same time, PEG does not require special equipment and technical support and its cost is relatively low, making it easy for patients to accept. It is a worthwhile method of enteral nutrition for clinical promotion and application.[24] The results of this study showed that after treatment, body weight, serum total protein, serum albumin, hemoglobin, and BMI of the 2 groups were better than before treatment, and the PEG group was better than the control group. This indicated that the liver protein synthesis function of patients treated with PEG gradually recovered, and the protein and energy provided were conducive to rapid body repair and enhancement of immunity. The incidence of gastrointestinal bleeding, aspiration pneumonia, and reflux esophagitis in the PEG group was lower than in the control group. This indicated that the incidence of complications after PEG catheterization was lower and the application was safe and reliable. However, the results from the FOOD trial showed there was no significant differences in outcomes between NG and PEG feeding routes in the broader stroke population.[25] However, our study focused on children with dysphagia after TBI. Also, all the children received comprehensive training methods including oral sensation training, oral exercise training, and physical therapy for swallowing dysfunction. Compared to FOOD TRIAL, there are several differences in the enrolled population, comprehensive treatment management methods, and comorbidities with underlying diseases.

This study showed that after comprehensive rehabilitation treatment for dysphagia, the WTA scores and DDS scores of the control group and the treatment group were significantly reduced compared to before treatment, indicating that the comprehensive rehabilitation treatment method for dysphagia was effective. The treatment group score was significantly lower than that of the control group, indicating that improving nutritional status could also effectively improve swallowing disorders. After improving nutritional status, improving dysphagia should be multifaceted. The growth and development of children with an improved nutritional status could be guaranteed, accompanied by the promotion of the growth and development of neural functions, which was more conducive to the improvement of dysphagia.

The study showed that swallowing training combined with neuromuscular electrical stimulation can effectively promote dysphagia after stroke.[26] Neuromuscular electrical stimulation can improve the strength of the hyoid muscle group, thus achieving an improvement in swallowing function in patients. Individualized swallowing training mainly adopts neural facilitation techniques and the principle of neuronal remodeling.[27] Through passive and active movements of the cheek, lip, and glossopharyngeal muscles, it can enhance the excitability of the nervous system, improve articulation and blood circulation in swallowing organs, regulate pharyngeal muscle coordination, induce pharyngeal muscle contraction, promote the formation of normal swallowing patterns, improve swallowing reflex flexibility, and ultimately promote recovery of swallowing function. Neuromuscular electrical stimulation can enhance peripheral sensory input, especially enhancing proprioceptive input, which can promote the recovery of motor function in children. At the same time, it can enhance muscle strength and tension by awakening local nerves and muscles, forming muscle contraction, thus promoting recovery of swallowing muscle strength and tension, and improving swallowing function.[28,29]

In summary, the comprehensive training method for swallowing disorders combined with enteral PEG nutrition has a definite effect on children with swallowing disorders after TBI. It is of positive importance in improving the nutritional status of children and in promoting recovery from swallowing function. The incidence of adverse reactions is low, and it deserves further promotion and application. Our findings require confirmation through larger-scale validation studies.

Author contributions

Conceptualization: Ling Zhang, Ji-Hong Hu.
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Funding acquisition: Ji-Hong Hu.
Validation: Ji-Hong Hu.
Visualization: Ji-Hong Hu.
Writing – original draft: Ling Zhang, Jing Cao, Ji-Hong Hu.

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