Case report: two case reports of the effect of repetitive peripheral magnetic stimulation on pharyngeal dysphagia

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Abstract

Dysphagia is a common sequela after a stroke, significantly impacting the overall recovery outcome. Complications associated with poststroke dysphagia, such as aspiration pneumonia, dehydration, malnutrition, and, in some cases, death, highlight the importance of screening and proper management as essential tools. This study aims to evaluate the effectiveness of repetitive Peripheral Magnetic Stimulation (rPMS) intervention in the pharyngeal dysphagia stage. Two cases of poststroke dysphagia were recruited for treatment, with a frequency of 20 Hz and 35% intensity, for a total of 1,200 pulses per session twice per week and a total of 16 sessions. Changes in the Eating Assessment Tool-10 (EAT-10) score and the Functional Oral Intake Scale (FOIS) level were recorded, showing improvement in both parameters. As a result, the patients could remove the nasogastric (NG) tube and resume an oral diet with the assistance of swallowing maneuvers. The findings suggest that rPMS may be beneficial for addressing pharyngeal stage dysphagia.

Keywords: repetitive Peripheral Magnetic Stimulation (rPMS), Pharyngeal dysphagia, poststroke dysphagia (J Thai Stroke Soc. 2024;23(3): 37-45)

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รายงานการศึกษา: ผลการกระตุ้นระบบประสาทส่วนปลายด้วยการใช้คลื่นแม่เหล็กไฟฟ้า ในการรักษาภาวะกลืนลำบากระยะคอหอยของผู้ป่วยโรคหลอดเลือดสมองจำนวน 2 ราย

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บทคัดย่อ

ภาวะกลืนลำบากเป็นภาวะที่พบบ่อยภายหลังการเกิดโรคหลอดเลือดสมอง ทำให้เกิดภาวะแทรกซ้อน เช่น โรคปอดอักเสบจากการสำลัก ภาวะขาดน้ำและภาวะทุพโภชนาการ ในบางครั้งอาจรุนแรงจนนำไปสู่การเสียชีวิตได้ การคัดกรองและให้การรักษาฟื้นฟูที่เหมาะสมจึงมีความสำคัญ ซึ่งปัจจุบันมีการนำเครื่องมือใหม่ๆเพื่อเพิ่มประสิทธิภาพการรักษานอกจากการฟื้นฟูสภาพดั้งเดิม การศึกษานี้มีวัตถุประสงค์เพื่อประเมินผลของการกระตุ้นระบบประสาทส่วนปลายด้วยการใช้คลื่นแม่เหล็กไฟฟ้า (rPMS) ในภาวะกลืนลำบากระยะคอหอย รายงานการศึกษาในผู้ป่วย 2 รายที่ได้รับการกระตุ้นครั้งละ1,200 ช็อคบริเวณกล้ามเนื้อคอหอย โดยใช้ความถี่ 20 Hz และความแรงในการกระตุ้น 35% รวมทั้งหมด16 ครั้ง ร่วมกับบันทึก Eating Assessment Tool-10 (EAT-10) และ Functional Oral Intake Scale (FOIS) โดยหลังจบการศึกษาผู้ป่วยสามารถถอดสายให้อาหารทางจมูกและกลับมารับประทานอาหารทางปากได้ โดยมีค่าการเปลี่ยนแปลงของข้อมูลที่ดีขึ้นจากก่อนการรักษา ผลการศึกษาอาจช่วยสนับสนุนผลของการรักษาภาวะกลืนลำบากในระยะคอหอยด้วยการกระตุ้นด้วยเครื่อง rPMS ร่วมกับการรักษาฟื้นฟูสภาพแบบดั้งเดิม

คำสำคัญ: การกระตุ้นระบบประสาทส่วนปลายด้วยการใช้คลื่นแม่เหล็กไฟฟ้า, กลืนลำบากระยะคอหอย, โรคหลอดเลือดสมอง (J Thai Stroke Soc. 2024;23(3): 37-45)

Introduction and objective

Dysphagia in stroke patients often has a favorable prognosis or resolves spontaneously. However, it has been reported that 11–50% of patients still experience dysphagia 6 months after symptom onset[1, 2], necessitating ongoing rehabilitation tailored to their specific swallowing difficulties. Therefore, assessment of dysphagia in acute stroke patients will help in planning care, including providing early rehabilitation to prevent complications leading to death later. Patients undergo bedside clinical examination for screening, and those identified may require a standard swallowing test utilizing tools such as videofluoroscopic swallowing study (VFSS) or Flexible endoscopic evaluation of swallowing (FEES)[3]. The guidelines for swallowing rehabilitation typically include conventional therapies, which encompass swallowing exercises, maneuvers, postural techniques, and dietary modifications[4].

Transcranial Magnetic Stimulation (TMS) is a widely popular method for stimulating the brain using magnetic fields. It is a treatment tool for various brain and nervous system diseases, offering a non-surgical and medication-free approach. TMS has been employed in patients with medication-resistant depression, achieving a 40% effectiveness rate[5]. For the treatment of dysphagia patients, TMS's ability to stimulate the motor cortex via the cortico-bulbar tract was reported, effectively enhancing the function of the pharyngeal muscles[6]. Park[7] conducted a study in which they applied 5Hz rTMS stimulation to the brain contralateral to the pathology for 10 minutes per day over two weeks. The evaluation of treatment results revealed its significant effectiveness in improving pharyngeal swallowing. It resulted in observable differences in the Penetration-Aspiration Scale (PAS) scores when assessing swallowing before and after TMS treatment using VFSS. However, brain stimulation is the potential risk of seizures. As an alternative, repetitive Peripheral Magnetic Stimulation (rPMS) therapy targets muscles and nerves. Exactly, the principle of rPMS involves delivering electrical current through magnetic coils to induce electromagnetic waves capable of penetrating tissue and bone. This induction triggers depolarization upon the opening of voltage-gated sodium channels, adjusting the threshold potential level and facilitating faster stimulation of action potentials. Consequently, this process enhances the transmission of information between various cells. We utilize this principle to effectively stimulate nerves and muscles further[8]. A report discussed using rPMS to stimulate the suprahyoid muscle area in two patients with restricted hyoid bone movement from the disuse syndrome after the history of aspiration pneumonia and in patient with dermatomyositis. The study observed improvements in hyoid elevation and the ability to swallow 4 mL of nectar after rPMS was performed for at least 5 days per week for 6 weeks[9]. In Momosaki et al.'s study of eight stroke patients, a stimulation frequency of 20 Hz with repetitive 20 trains over 10 min followed by 20 min of an intensive swallow rehabilitation program. The rPMS were stimulated twice daily for six consecutive days in hospital admission. This approach yielded positive results in swallowing ability, larynx elevation delay time, PAS, and swallowing quality of life ($p<0.01$)[10]. In studies involving the use of rPMS in post-stroke rehabilitation, particularly in stimulating the hemiplegic limb, signals are sent to the brain. This process allows the functional parts of the brain to recover and subsequently send signals back down, thereby promoting improved movement in the affected limbs. Additionally, stimulating

muscles with rPMS has been shown to reduce muscle spasms. This effect is believed to occur through the stimulation of A-delta fibers and increased activation of joint and muscle sensors. By modulating the speed of nerve conduction to an appropriate level, rPMS effectively reduces the symptoms of muscle contraction or directly diminishes muscle contraction itself[8, 11].

There have been few studies on the use of rPMS in swallowing therapy and no established standard protocol for treatment guidelines. Stimulation intensity is typically set to a level where the patient does not experience pain. Frequency settings range from 20 to 30 Hz, and the duration of treatment can vary between 1 to 2 weeks in hospital admission. The protocol lacks consensus and there have been no reports of outpatient setting treatment. By adjusting the protocol, the researcher aims to explore the feasibility of using the rPMS to treat post-stroke pharyngeal phase dysphagia in the outpatient department (OPD) setting.

Methods

Stroke patients sent to the dysphagia clinic for rehabilitation are diagnosed with pharyngeal stage dysphagia by a PM&R physician. These patients undergo comprehensive data collection related to their stroke and dysphagia assessment. This includes bedside swallow screening, evaluation using the Functional Oral Intake Scale (FOIS) to assess oral intake function, and completion of The Eating Assessment Tool (EAT-10) to evaluate swallowing difficulties and their impact on daily life.

FOIS consists of 7 levels, ranging from complete dependence on tube feeding (Level 1) to independent consumption of a regular diet without any restrictions (Level 7). Each level represents a different degree of oral intake capability, including tube dependence, oral trials, and variations in diet consistency. On the other hand, the EAT-10 consists of 10 questions focusing on symptoms such as difficulty swallowing, choking, and the need to modify food or liquid consistency. Responses are scored on a scale from 0 to 4, with higher scores indicating more severe swallowing problems. The symptoms, such as nasal regurgitation, multiple attempts to swallow, or coughing after swallowing, serve as cues of a potential pharyngeal stage problem. Upon examination, a decrease in laryngeal elevation or reflex swallow may also be observed. Then the patients underwent a FEES assessment, including a 3 mL water swallow test to represent the clear liquid test, followed by International Dysphagia Diet Standardisation Initiative (IDDSI) level 2 and 4 food trials to assess PAS before stimulation. If unable to swallow, posture adjustment techniques were considered appropriate.

In this study, we utilized a MagPro R20 magnetic stimulation device in combination with a parabolic coil placed around the suprahyoid muscle as in picture 1. The coil shape does not appear to make contact with the area of stimuli due to its diameter being 143 x 14.5 / 5.63 x 0.57 inches. However, considering the penetration depth (70 V/m) of 44.3 mm/1.74 inches, we assume that the magnetic field reaches the intended target area. Stimulation was applied at a frequency of 20 Hz. Therefore, the parameter setting on our machine was adjusted to 20 trains with 60 pulses per train, to achieve a total of 1,200 pulses per session following Momosaki's protocol. The intensity of this setting is set at a maximum of 35%. When adjusting the intensity for visible hyoid elevation muscle movement in both patients, they both utilize a 35% intensity level. The treatment regimen was two sessions per week, so we extended the treatment sessions

for 8 weeks incorporating FEES and EAT-10 assessments. Treatment results were evaluated at various time points, including after the initial stimulation, and immediately after the 1st, 8th, and 16th sessions of rPMS as figure 1. The occupational therapy program continues to incorporate combined treatment strategies with individualized adjustment programs. These may include oromotor exercises, pharyngeal muscle strengthening exercises, and the implementation of postural or compensation techniques tailored to each patient's specific needs.

Results

First case: Lateral medullary syndrome

The first case was a 43-year-old male with underlying hypertension and dyslipidemia, experiencing dysphagia for 4 months, who was diagnosed with lateral medullary syndrome. Following the stabilization of his stroke condition, he was referred by a private hospital for swallowing rehabilitation. Prior dysphagia treatments included swallowing exercises and neuromuscular electrical stimulation (NMES). However, the individual continues to rely on nasogastric tube feeding due to ongoing difficulty with swallowing.

Assessment:

- Stroke conditions: Good consciousness, able to follow commands. Motor power at grade 5 in all extremities.
- Functions: Independent walking and self-sufficient in daily activities, except for eating. Reliant on an NG tube for feeding with FOIS 1.
- Swallowing problems: Body mass index (BMI) of 23, facial palsy, repetitive saliva swallowing test (RSST) less than 3, laryngeal excursion approximately 1 fingerbreadth (FB), water swallow test with 3 mL modified water swallowing test (MWST) scored of 3.

Results

PMS session	Penetration-aspiration scale			
	IDDSI 0 (3mL.)	IDDSI 2 (3mL.)	IDDSI 4 (3mL.)	EAT-10
Pre-treatment	3	3	3	40
Immediate post-rPMS 1st session	3	3	3	
Post rPMS 8th session	3	7	3	32
Post rPMS 16th session	0	2	2	28

After the 13th PMS session, he was able to have the NG tube removed, and he gradually transitioned to a regular diet, including liquids that he could drink from a cup. To aid in clearing any food retention, he drank water following meals. FOIS was changed to level 5.

Second case: Ischemic stroke

A 63-year-old male presented with dysarthria and no motor weakness for the past 2 months. His underlying health conditions included hypertension and a history of old pulmonary tuberculosis. The CT brain investigation revealed old lesions in the right thalamus, bilateral basal ganglion, and periventricular region. He

experienced swallowing difficulties, and after failing a screening test, he continued with nasogastric tube feeding. He attended the dysphagia rehabilitation clinic during a follow-up appointment recommended by the neurologist. He consumes 300 cc of blenderized food during each feeding session, with a total of four feeds per day. Occasionally, he tries to consume a chocolate malt beverage during feeding sessions, with no reported aspiration based on his self-assessment.

Assessment

- Stroke conditions: Moderate dysarthria. Motor power at grade 5 in all extremities.
- Functions: Independent walking and self-sufficient in daily activities, except for eating. Reliant on an NG tube for feeding with FOIS 2.
- Swallowing problems: Body mass index (BMI) of 15, with weight reduction of 6 kilograms from baseline. Impaired tongue movement in all directions, swallowing reflex was 2 seconds, laryngeal excursion 2 FB, water swallow test with 1, 5 mL water swallowing test result in no aspiration but when to swallow 10 mL, he used double swallow for clearing.
- During the dysphagia rehabilitation program, he experienced discomfort and sensation of retention in the pharyngeal region while attempting to swallow boiled rice, poached eggs, and boiled eggs. The utilization of postural techniques, such as chin tuck, and drinking water following the swallow occasionally assisted in clearing the discomfort.
- In the 6th session of the rPMS, he expressed a desire to discontinue the NG tube due to enhanced tolerance for oral feeding at IDDSI levels 3 (liquid porridge blender) and 4 (coarsely blended porridge) and discomfort. To help swallow the effortful swallowing technique was used and traditional exercises such as tongue strength were performed, finally FOIS 5.

Results

PMS session	Penetration-aspiration scale (PAS)			
	IDDSI 0 (3 mL.)	IDDSI 2 (3 mL.)	IDDSI 4 (3 mL.)	EAT-10
Pre-treatment	3	3	3	29
Immediate post-rPMS 1st session	3	3	3	
Post rPMS 8th session	1	3	3	17
Post rPMS 16th session	1	2	2	2

Discussion and conclusion

Although some stroke patients may resolve their swallowing problems, approximately 50% of patients still report persistent impairments in swallowing[12].

Reports on quality of life indicate an adverse impact, with 41% of patients experiencing anxiety during eating, and more than 1/3 of patients choosing to avoid oral intake, particularly with certain types of foods. In difficult cases where oral eating is not possible, patients may require an alternative route of feeding. One study reported that 80% of patients with prolonged dysphagia

needed alternative means of enteral feeding[13].

Current treatments mainly consist of intensive swallow rehabilitation, with other interventions being used for comparison or in combination with traditional treatments. Comparative studies have shown that combining NMES or TMS with standard therapy is more effective than using NMES or TMS alone. Pharmacological agents such as slow-release nifedipine, administered orally at a dosage of 30 mg, have shown improvement in the initiation of pharyngeal contractions and reduction in the time taken for a bolus to traverse the pharynx in cases of persistent dysphagia following stroke onset within two weeks. Additionally, incorporating acupuncture into early comprehensive rehabilitation for patients with mild to moderate acute ischemic stroke has demonstrated improvements in neurological deficit, cognitive impairment, and swallowing function. However, additional research is required to corroborate these results[12].

The results of rPMS in this study demonstrate an improvement in swallowing for both cases. The patients were able to elevate their FOIS to level 5, occasionally employing swallowing techniques to address food retention after completing the rPMS course. Both individuals exhibited different baseline scores before and after treatment in the EAT-10, which assesses swallowing difficulty and its impact on life through 10 questions. This implies an enhancement in the quality of life.

In the parameter setting, the intensity level is determined by the visibility of pharyngeal muscle contraction. Both patients utilized the maximum intensity of the device (35%) to observe muscle contractions without reporting any pain sensations. The coil is positioned in the hyoid muscle area to effectively stimulate the target muscles in the pharyngeal stage, aligning with the principles of rPMS. The parabolic coil can be used as a stimulation site for inducing visible muscle contractions. Since the stimulation is designed to occur twice per week, the number of treatment sessions could extend from the previous study. As a result, in the second case, the patient was able to drink clear liquids or IDDSI level 0 with improved PAS at four weeks. In the first case, the patient could safely drink by the end of the stimulation course. Both cases demonstrated improvement in the diet swallow test with IDDSI levels 2 and 4 after 4-8 weeks of treatment, suggesting the potential effectiveness of rPMS in an outpatient department (OPD) setting, particularly in hospitals that limit services in the OPD. However, on the other hand, there could be travel and financial challenges associated with visits, leading to inconvenience. Consequently, we were only able to recruit two patients to participate in this study.

In the strategy for swallowing training in post-stroke dysphagia, traditional treatment remains crucial. However, for cases presenting challenges in management or where rPMS is not recommended, such as in patients with epilepsy or those with metal or electronic devices in their bodies, rPMS appears to offer potential benefits for additional treatment.

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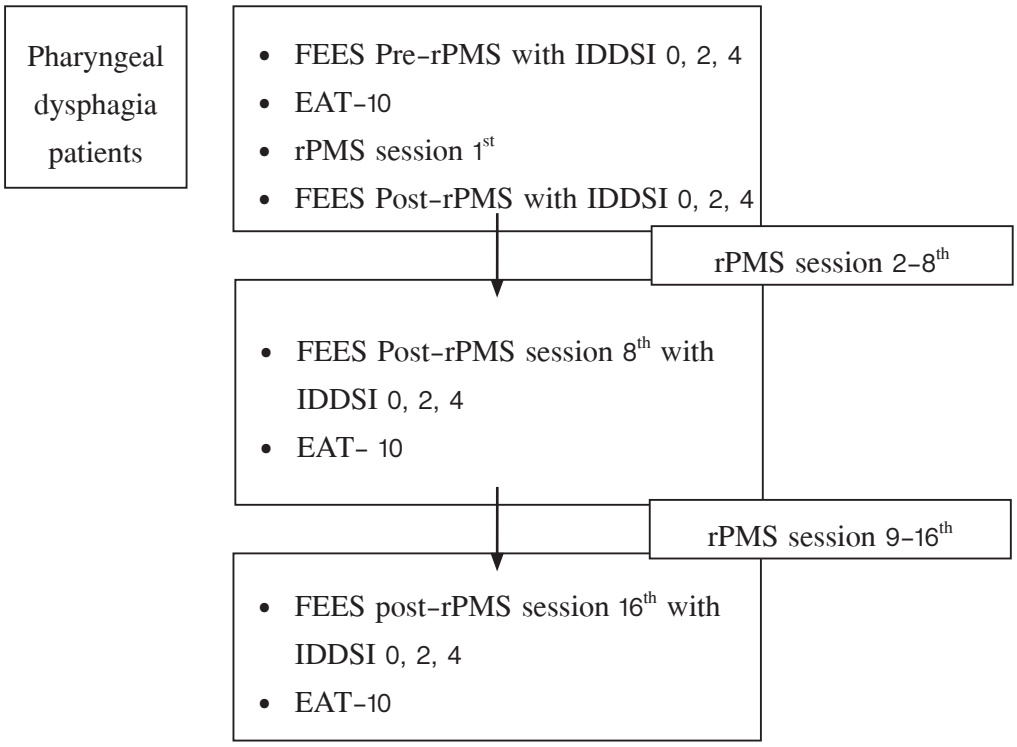
Figure 1. *Flow of treatment*



FEES: Flexible endoscopic evaluation of swallowing

EAT-10: Eating Assessment Tool

IDDSI: International Dysphagia Diet Standardisation Initiative

Picture 1. *coil placement*