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Case Report

Repetitive Transcranial Magnetic Stimulation (rTMS) as Non-Invasive Therapeutic for Post-Stroke Dysphagia: A Case Report

Jumraini Tammasse[1], Andi Kurnia Bintang[1], Muh. Iqbal Basri[1], A. Ahwal M.H. Rauf[1]

[1]*Department of Neurology, Faculty of Medicine, Universitas Hasanuddin, Indonesia*

Corresponding Author:
Name: Jumraini Tammasse
Email: jumraini.tammasse@gmail.com

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ABSTRACT

Introduction and importance: *Dysphagia is one of the biggest problems that can happen to persons with a stroke. Stroke survivors with post-stroke dysphagia must be treated effectively with tried-and-true procedures for better outcomes. This case report assesses the short-term effects with low-frequency of rTMS on cortical excitability and swallowing function of stroke patients with severe dysphagia.* ***Presentation of case:*** *A 64-year-old man complained of difficulty swallowing with Gugging Swallowing Screen scoring (GUSS)=7 (severe dysphagia) with left hemiparesis and slurred speech due to an ischemic stroke on August 14th, 2022. Head CT Scan found bilateral lacunar basal ganglia infarcts with brain atrophy. Patients were treated with standard ischemic stroke therapy, medical rehabilitation, and repeated Transcranial Magnetic Stimulation (rTMS) with low-frequency 3 Hz procedures for 10 consecutive days. After undergoing rTMS intervention for 1 cycle of 10 sessions, the patient experienced significant changes, and the complaints of dysphagia have decreased with moderate dysphagia of GUSS.* ***Discussion:*** *The rTMS modulates cortical excitability and minimizes the imbalance between the hemispheres by stimulating the esophagus cortex bilaterally in post-stroke dysphagia. Furthermore, it appears to be safe and well-accepted by patients.* ***Conclusions:*** *Short term effects with low-*

frequency of rTMS in the bilateral esophageal cortex is safe and has therapeutic potential in patients with post-stroke dysphagia.

1. INTRODUCTION

One of the worst complications that affects people with stroke is dysphagia. Dysphagia causes mortality through dehydration, malnutrition, aspiration pneumonia, and suffocation.[1] Malnutrition is quite common in post-stroke dysphagia patients, with prevalence reaching 62%. Due to poor functional results, a rise in comorbidities, length of stay, an increase in mortality, and more significant hospitalization expenditures, clinicians must identify malnutrition.[2,3] According to a study by Banda et al., pneumonia was four times more likely to occur in acute stroke patients with dysphagia than in those without it.[4] About 35% of post-stroke mortality is caused by one of the top post-stroke killers: pneumonia. Most post-stroke pneumonia is brought on by dysphagia.[5] Therefore, the clinicians can prevent further post-stroke dysphagia issues with proper care.[6]

Swallowing function may improve within a few weeks following a stroke. Although it is believed that this recovery from dysphagia following a stroke follows a typical remodeling of the motor cortex, each patient's level of recovery differs. Recovery from dysphagia is known to be correlated with reorganization in the swallowing cortical area following a stroke. Current dysphagia treatment goals include aspiration prevention through dietary management and rehabilitative exercises. Diverse therapy modalities, such as sensory stimulation of the oral and facial regions, strengthening of the oral and pharyngeal muscles, compensating procedures, and thermal tactile stimulation, have been utilized for dysphagia rehabilitation to enhance the patient's swallowing performance.[6]

2. CASE PRESENTATION

A 64-year-old man complained of difficulty swallowing with left hemiparesis and slurred speech after an ischemic stroke on August 14th, 2022. Physical examination E4M6V5, cranial nerves parese NVII and XII left central type, left limb strength 0, positive pathological reflexes on the left foot, sensory hemihypesthesia left side, with Gugging Swallowing Screen scoring (GUSS)=7 (severe dysphagia). Head CT scan without contrast describes bilateral lacunar basal ganglia infarcts with brain atrophy. Patients were treated with standard ischemic stroke therapy, medical rehabilitation, and repeated Transcranial Magnetic Stimulation (rTMS) procedures for 10 sessions in 10 consecutive days. The GUSS was increased to 14 (moderate dysphagia) after the 10th session of rTMS.

Here is the rTMS (repetitive Transcranial Magnetic Stimulation) procedure we use on patients (Table 1):

1. The patient is in a sitting position.
2. The coil used is a butterfly coil that is placed on the bilateral esophageal cortical regions (Figure 1) .
3. The patient received rTMS therapy with a 3 Hz depression protocol for 10 sessions in 10 consecutive days.

Table 1. Repeated Transcranial Magnetic Stimulation (rTMS) protocol

Protocol	Setting	Location	Motor threshold
3 Hz Depression	• Stimulation type: Burst • Stimulus amplitude (% MT): 80 • Burst frequency in train (Hz): 5,0 • Pulses frequency in burst (Hz): 50 • Burst in train: 20 • Pulses in burst: 3 • Number of trains: 10 • Intertrain interval(s): 8,0	Bilateral esophageal cortical regions	60

Fig. 1. Stimulation of 3 Hz rTMS in a patient was applied to bilateral esophageal cortical regions (3 cm anterior and 6 cm lateral to the vertex).

During the study, rTMS appeared safe and well tolerated by our patients. Our findings suggest promising clinical effects can be provoked by stimulating the bilateral esophageal cortex in patients with ischemic post-stroke dysphagia. The patient can perform daily activities without difficulty, resulting in higher Barthel Index scores. After undergoing rTMS intervention for 1 cycle of 10 sessions, the patient experienced significant changes, and until now, the complaints of dysphagia have decreased.

3. DISCUSSION

During rehabilitation from post-stroke dysphagia, non-invasive brain stimulation approaches are anticipated to modify brain plasticity.[1] Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive technique used to stimulate the brain since it is known to be beneficial in lowering post-stroke interhemispheric imbalance and managing cortical excitability.[7] Synaptic alterations are involved in the long-term effects of rTMS and can be explained by procedures resembling long-term plasticity of potentiation and depression (LTP/LTD)--an in vitro model of repeated magnetic stimulation excitability. The entorhinal-hippocampal organotypic pattern provides direct support for this hypothesis. It was found that 10 Hz stimulation increased glutamatergic synaptic strength, enlarged dendritic spines, and increased levels of GluA1.[8,9] This further validates the claim.[10,11]

The coil is positioned in the cortex's desired location. During rTMS stimulation, the electric current delivered in the coil generates a magnetic field perpendicular to the

plane of the coil. The targeted neurons may depolarize with the appropriate stimulus. By reducing neural excitability, stimulation at low frequencies (1 Hz) has an inhibitory impact. On the other hand, stimulation at high frequencies (about 3 Hz) makes neurons more excitable.[12]

Studies using rTMS reported the role of non-invasive brain stimulation techniques in dysphagia recovery. Patients with post-stroke dysphagia who underwent bilateral 3 Hz rTMS stimulation of the pharyngeal motor cortex and swallowing rehabilitation exercises concluded that combining the rTMS treatment and the exercises was safe and beneficial.[6] Patients with acute post-stroke dysphagia were stimulated for two months in the esophagus brain area, and Khedr et al. discovered that both dysphagia and motor impairment had improved.[13] Verin and Leroi used rTMS to stimulate the mylohyoid cortical area of the healthy hemisphere in patients with persistent post-stroke dysphagia. They discovered improvements in swallowing coordination and a decline in liquid aspiration scores. Previous research used rTMS to treat the swallowing muscles' cortical lesions and found considerable enhancements.[14] Other studies related to rTMS with stroke and dysphagia are listed in Table 2.

Table 2. Studies that examine the effects of rTMS on swallowing function

Author	Number of patients	Time from stroke onset	Stimulation sites	Stimulation methods	Clinical effects
Khedr EM, et al. (Acta Neurol Scand 2009	26 Stroke (unilateral cerebral lesion)	5-10 days	The Lesional primary motor area	3 Hz (120%)	Improved dysphagia score
Verin E, et al. (Dysphagia 2009)	7 stroke (2 cerebellar lesion)	11-32 months	Non-lesional primary motor area	1 Hz (120%)	Improved swallowing response time, pharyngeal residue, and aspiration score
Khedr EM, et al. (J Neurol Neurosurg Psychiatry 2010)	22 brainstem or medullary infarction	Within 3 months	Both primary motor cortices	3 Hz (130%)	Improved grade of dysphagia
Kim L, et al. (Ann Rehabil Med 2011)	2 brain injury, 28 stroke (unilateral cerebral lesion)	Within 3 months	The Lesional or non-lesional primary motor area	1 Hz or 5 Hz (100%)	Improved dysphagia scale, aspiration, and laryngeal penetration at 1 Hz
Michou E, et al. (Gastroenterology 2012)	6 stroke (unilateral cerebral lesion)	6 months or longer (mean 38,8 weeks)	Non-lesional primary motor area	PAS	Improved pharynx transit time, aspiration, and laryngeal penetration
Park JW, et al. (Neurogastroenterol Motil 2012)	18 stroke (unilateral cerebral lesion)	1-3 months	Non-lesional primary motor area	5 Hz (90%)	Improved dysphagia scale, aspiration, and laryngeal penetration

Zhong L. et al. showed that 5 Hz rTMS on the ipsilateral hemisphere, contralesional hemisphere, and cerebellum for 10 days improved swallowing function in post-stroke dysphagia patients. However, the 3 sites were the same. Regardless of the site of rTMS, mylohyoid cortical tissue positively affected patients with post-stroke dysphagia. In addition, cerebellar rTMS is also a safe method that represents a potential treatment for post-stroke dysphagia.[15]

The research by Khedr et al., who used active rTMS for 5 consecutive days with 3 Hz stimulation positioned over the esophageal cortex area of both hemispheres (the best place for stimulation is approximately 3 cm anterior and 6 cm lateral vertex), and who obtained improved swallowing function, supported the choice of bilateral esophageal cortex stimulation as the stimulation site. These results imply that rTMS could be a helpful additional method in the neurorehabilitation of dysphagia.[16]

Several studies have been conducted regarding the non-invasive therapeutic modality of rTMS with various frequencies and duration of administration. Our study showed clinically significant and the GUSS more improved than other studies result with rTMS administration time of 3 Hz for 10 days. Furthermore, a low-frequency of 3 Hz with 10 sessions for 10 days can be a benchmark for further research to assess. More studies need to be conducted to establish the effect of rTMS on the bilateral esophageal cortex's recovery of swallowing function, which includes several clinical outcomes.

4. CONCLUSION

Our case study shows that rTMS to the bilateral esophageal cortex is safe and has therapeutic potential in patients with post-stroke dysphagia. Using rTMS in post-stroke dysphagia may be beneficial, but no large-scale (or multicenter) randomized controlled study has been conducted. Measuring neurophysiological and functional outcomes will give us more information about endogenous plasticity changes related to swallowing function in humans.

CONSENT FOR PUBLICATION

All contributing authors are requested to indicate that they have read and accepted the final version of this manuscript, that they have made all necessary statements at the time of acceptance, and to provide their agreement to publishing.

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Conflict of Interest Statement:

The author declares that the case report was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.