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## PILOT STUDY

# A pilot study on the effects of low frequency repetitive transcranial magnetic stimulation on lower extremity spasticity and motor neuron excitability in patients after stroke



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### KEYWORDS

Stroke;  
Spasticity;  
rTMS;  
H-reflex;  
Function;  
Therapy

**Summary Purpose:** To evaluate the effect of low frequency, repetitive transcranial magnetic stimulation (rTMS) on the lower extremity spasticity and motor neuron excitability in patients after stroke.

**Methods:** Seven patients after stroke aged 42–78 years were included in this pretest-posttest clinical trial. The rTMS at 1 Hz and duration of 20 min was applied to the intact leg motor cortex for five consecutive sessions. Primary outcome measures were the Modified Modified Ashworth Scale (MMAS) and the  $H_{max}/M_{max}$  ratio. Measurements were taken at baseline (T0), after the last treatment (5th) session (T1), and at 1 week follow up (T2).

**Results:** Clinically assessed ankle plantar flexor spasticity ( $p = 0.05$ ) improved significantly after treatment at T1. Knee extensor spasticity scored 0 after treatment at T1 and T2. The  $H_{max}/M_{max}$  ratio showed no statistically significant improvement after treatment.

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**Conclusion:** The pilot data indicate that the inhibitory rTMS of the intact leg motor cortex in patients after stroke may improve the lower extremity spasticity.

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## Introduction

Stroke is a major cause of acquired disability in adults. After stroke, patients exhibit symptoms such as spasticity, weakness, and walking impairment. Spasticity was defined as a velocity dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper excitability of the stretch reflex (Lance, 1980). The prevalence of spasticity 6 months after first-ever stroke is around 43% (Urban et al., 2010). Spasticity must be treated, as it may limit functional recovery, and cause muscle contractures, motor weakness, pain, and ankylosis. In addition to physical therapy, oral medications, focal treatments and surgical procedures have been used for management of spasticity.

Repetitive transcranial magnetic stimulation (rTMS) is one of the therapeutic modalities that have been recently suggested by researchers for managing muscle spasticity in different upper motor neuron diseases. The rTMS is a therapeutic, noninvasive, and effective tool that can alter human cortical excitability (Ridding and Rothwell, 2007). Depending on the frequency of stimulation, 2 modes of rTMS are commonly used: 1) high frequency (more than 1 Hz) facilitatory mode for increasing the damaged hemisphere excitability, and 2) low frequency (equal or less than 1 Hz) inhibitory mode for decreasing the intact hemisphere excitability to reduce the interhemispheric inhibition from the intact to the damaged hemisphere (Takeuchi and Izumi, 2012).

The rTMS has been used in various neurological conditions of multiple sclerosis (Centonze et al., 2007; Mori et al., 2010), spinal cord injuries (Kumru et al., 2010, 2013), and cerebral palsy (Valle et al., 2007) to control muscle spasticity. There are studies which investigated the effects of rTMS on upper extremity spasticity in patients with chronic stroke (Mally and Dinya, 2008; kakuda et al., 2011). In a study by Mally and Dinya, 64 patients with chronic stroke in a stable state were followed for 3 months, and were treated with rTMS with 1 Hz twice a day for a week. Authors reported that paretic arm muscle spasticity can be modified with the rTMS (Mally and Dinya, 2008). To determine the effects of rTMS combined with occupational therapy on the spasticity of the hemiparetic upper extremity after stroke, 39 patients post-stroke with spastic upper extremity were included. Patients received 22 sessions of low frequency rTMS applied to the intact hemisphere and showed a significant improvement of both finger and wrist flexor spasticity after treatment (kakuda et al., 2011). Studies have shown that the rTMS may be effective in the treatment of lower extremity spasticity and modulating cortical excitability of the leg motor area (Mori et al., 2009). To our knowledge no study has investigated the effect of inhibitory rTMS on lower extremity spasticity and

motor neuron excitability post-stroke. The purpose of the present study was to investigate the effect of low frequency rTMS on the lower extremity spasticity and the motor neuron excitability in patients after stroke.

## Methods

### Study design

This study is a single-group, pretest-posttest clinical trial. The study protocol was reviewed and approved by the Research Council, School of Rehabilitation and the Ethics Committee of Tehran university of Medical sciences, Iran. The written informed consent was obtained from all participants.

### Participants

Inclusion criteria for participants were as follows: (1) first-ever stroke which resulted in unilateral hemiparesis; (2) duration of poststroke  $\geq 6$  months; (3) ability to walk independently (with or without walking aids); (4) age  $\geq 18$  years. Exclusion criteria were: (1) the presence of contraindications for the use of TMS (e.g. cardiac pacemaker or intracranial implants); (2) taking anti-spastic drugs; (3) and local injection of botulinum toxin type A in the past 3 months.

### Procedure

Patients after stroke were recruited from the Rehabilitation Centre of Firoozgar University hospital. The information about the age, gender, time after stroke, side of hemiparesis, and location of the lesion were obtained through interview with patients and brain magnetic resonance imaging (MRI). Initially, the procedure of study was explained to the subjects. All outcomes were measured at three time points: 1) at baseline (T0), 2) after the last treatment (5th) session (T1), and 3) one week after the rTMS (T2). After the baseline assessments, patients received five consecutive daily sessions of rTMS in the morning between 8:00 AM and 12:00 AM. Immediately after the last treatment session, the assessments were performed. The follow-up assessments were performed one week after the end of rTMS treatment session. Both assessments and treatment for all patients were performed by a well-trained physiotherapist (PT).

### Outcome measures

Primary outcome measures were: (1) Modified Modified Ashworth Scale (MMAS) to assess muscle spasticity, and (2)  $H_{\max}/M_{\max}$  ratio as the index of motor neuron excitability.

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