

## Gait Rehabilitation in Patients with Calf Muscle Spasticity

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### Introduction

Spasticity is one of the major complaints of patients with spinal cord injuries. It has negative effects such as limitations in activities of daily living (ADLs), pain, fatigue, sleep disorders, instability, joint contractures, pressure ulcers, and infection, and decreases gait ability through changes in timing of gait-related muscle contraction and co-contraction [1,2]. Spasticity, also, is a major factor inhibiting functional recovery, as it reduces joint range of motion (ROM), joint contracture, and severe functional impairment of ADLs [3]. Erik et al. emphasized that aggressive treatment of spasticity is required as patients with spasticity have a 1-year treatment cost more than 4 times higher than that of patients without spasticity, indicating that spasticity increases not only functional limitations but also increases the financial burden [4,5]. Therefore, a multidisciplinary approach is being attempted to control spasticity in clinical settings.

The treatments generally used for the relief of spasticity in patients with spinal cord injury include medical treatments, physical therapy, and surgical therapy [6]; among them, medical treatment is the most common [7]. However, prescribed anti-spastic medications have adverse effects such as sedation, drowsiness, insomnia, fatigue, muscle weakness, ataxia, dizziness, hypotension, depression, reduction of memory and attention, hallucination, and toxicity-induced hepatic damage, which may negatively affect the quality of life of patients with spinal cord injury [8].

In physical therapy, electrical stimulation therapy, heat therapy, stretching stimulation therapy, and vibratory stimulation therapy are currently used [9]. Vibratory stimulation, as a method of somatosensory stimulation for the functional recovery of patients with brain lesions, has merits, in that, it has no significant adverse effects and no effort to learn an exercise method is necessary [10]. Interest in vibratory stimulation therapy has been increasing, as studies about rehabilitation therapy are being increasingly published since the 1990s [11]. Particularly, it has been reported that vibratory stimulation has significant inhibitory effects in patients with abnormal muscle contraction [12,13], and is effective in reducing spasticity in paralyzed patients [14]. This study showed that the reduction of spasticity in patients with spinal cord injury occurred by promoting reciprocal inhibition through vibration and interrupting the reflex causing spasticity [14]. That is, vibratory stimulation can have both stimulant and inhibitory effects in spinal reflex activity simultaneously. The stimulatory effect of vibration increases muscle contraction by constantly stimulating the vibration reflex, activating the muscle spindles receiving the vibration [15]. At the same time, vibration can have an inhibitory effect on spinal reflex activity. In spinal injuries, motor function abnormality and pain are caused by loss of presynaptic inhibition, and vibration can increase presynaptic inhibition [16]. Vibration also causes Achilles stimulation as well as the inhibition of

the soleus Hoffmann reflex occurring at the Ia afferent terminal of soleus [17]. Although the vibratory stimulus releases acetylcholine, a major neurotransmitter of muscle contraction, by stimulating primary afferent muscle fibers, constant stimulation of this may cause reduction of muscle contraction by neurotransmitter depletion and reducing the excitation of motor neurons. It has previously been shown that there are few adverse effects of vibration therapy in studies that used vibration therapy for therapeutic purpose in normal adults, the elderly, and children [18].

In our previous study [19], we developed a downsized local vibrator and demonstrated that local vibration with stimulation parameters of 70 Hz and a 65  $\mu$ m amplitude using the local vibrator on the gastrocnemius belly reduced the H-reflex, which was a quantitative indicator of alteration in the segmental reflex pathway, more than that on the Achilles tendon. A number of studies proved the physiologic effects of local vibration in young healthy subjects [20-25], and these effects were eventually applied to patients with neurologic disorders. Therefore, the purpose of the study was to determine effective local muscle stimulation parameters to inhibit the H-reflex of the gastrocnemius in young healthy subjects.

We also suggest that local muscle vibration may be an adjuvant therapy for gait rehabilitation in patients with calf muscle spasticity [26]. In this study, muscle stimulation with parameters of 80 Hz and 0.3 mm amplitude for local vibration on the gastrocnemius effectively inhibit the segmental reflex pathway.

It is supposed that the application of vibration therapy would be an effective intervention to reduce spasticity of gastrocnemius in patients with calf muscle spasticity. This may help the posture as well as the mobility of patients with calf muscle spasticity and ultimately have positive effects on their quality of life.

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