Effects of Talocrural Mobilization with Movement on Ankle Strength, Mobility, and Weight-Bearing Ability in Hemiplegic Patients with Chronic Stroke: A Randomized Controlled Trial

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Background and Objective: In general, adequate movement of the ankle joint is known to play an important role in functional activities. Stroke survivors frequently have limited range of motion of the ankle, leading to dysfunctional weight transfer toward the paretic lower limb during standing or gait. The purpose of this study was to investigate the effects of talocrural mobilization with movement (MWM) on ankle strength, dorsiflexion passive range of motion (DF-PROM), and weight-bearing ability on the paretic limb during standing or gait in stroke patients with limited ankle dorsiflexion. *Methods:* Twenty-six participants with chronic hemiplegia (>6 months post stroke) were divided into 2 groups: MWM group (n = 13) and control group (n = 13). Both groups attended conventional physiotherapy sessions 3 times a week for 5 weeks. Additionally, the MWM group underwent talocrural MWM 3 times a week for 5 weeks. Isokinetic ankle strength, DF-PROM, and weight-bearing ability measures included the limit of stability (LOS); gait parameters were evaluated before and after interventions. *Results:* Plantarflexors peak torque and DF-PROM significantly increased in the MWM group. In addition, forward and forward–paretic direction LOS significantly increased in the MWM group. Paretic direction LOS, single-limb support phase of the paretic limb significantly increased and double limb support phase significantly decreased within the MWM group. *Conclusions:* This study demonstrates that talocrural MWM has an augmented effect on ankle strength, mobility, and weight-bearing ability in chronic stroke patients with limited ankle motion when added to conventional therapy. **Key Words:** Ankle—stroke—talocrural mobilization with movement—weight-bearing ability.
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Introduction

The ankle plays a primary role in the maintenance and correction of the balance during standing or gait (i.e., adequate joint motion and selective muscle contraction).[1-4] According to a previous study, adequate ankle motion for normal gait ranges from 10° to 15° of dorsiflexion passive range of motion (DF-PROM) to allow the tibia to move over the talus.[5] However, limited ankle mobility is a common impairment in patients with stroke whose DF-PROM has been shown to be approximately half of that in healthy subjects.[6] As a result, these patients have impaired dynamic balance in standing or gait.

Neural factors, such as spasticity, or an increase in the sensitivity of the myotatic reflex, can contribute significantly to calf muscle stiffness.[6,7] Likewise, non-neural factors, such as immobilization and age-induced changes in the mechanical properties of muscle and connective tissue, are known to increase resistance to joint movement and to contribute to the limited DF-PROM.[8-10] Both neural and

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non-neural factors can impair ankle motion, resulting in balance impairments during standing or gait.

Limited DF-PROM can alter foot positioning in weight bearing, resulting in hyperextension of the knee, and decreased ability to shift the center of gravity (COG) during standing and gait.[11] A variety of interventions, such as stretching and joint mobilization, have been attempted to attenuate the effects of limited DF-PROM and to reduce further deterioration in patients post stroke.[12-14] Both stretching and joint mobilization have been proven effective for improving ankle passive range of motion in patients with stroke; however, there is a limit to the durability of the effect and improvements in functional ability.[12-14] For this reason, improvements in joint range of motion (ROM) must be accompanied by gains in muscle strength to improve functional ability. This is especially true for patients with hemiplegia who are not capable of weight bearing symmetrically and require additional training, including repetitive and continuous weight bearing on the paretic lower limb.[14-16]

Mulligan first proposed mobilization with movement (MWM) as a joint mobilization technique.[17] Talocrural MWM to facilitate DF-ROM is performed by applying a posteroanterior tibia glide over a fixed talus while the patient actively moves into a dorsiflexed position while standing.[18] Talocrural MWM has been applied to chronic ankle instability and has been proven effective in improving DF-PROM and standing balance.[19,20] However, the effects of talocrural MWM have not been investigated in patients with stroke. Talocrural MWM involves repetitive weight bearing combined with joint mobilization in the standing position, and, for this reason, can be expected to simultaneously improve DF-PROM and weight-bearing ability. Therefore, the purpose of the present study is to examine the effects of talocrural MWM on ankle strength, DF-PROM, and weight-bearing ability on the paretic limb during standing or gait in stroke patients with limited ankle mobility.

Methods

Design and Participants

Study participants were recruited from the university's neurological rehabilitation department and were patients with stroke who were currently undergoing therapy. This study design was a randomized controlled trial with 2 groups. For randomization, sealed envelopes were prepared before trial and marked inside with 1 or 2, 1 indicating the MWM group and 2 indicating the control group. A total of 26 patients with stroke participated in the present study, including 13 participants in the MWM group and 13 participants in the control group (Fig 1). The inclusion criteria for this study were hemiplegic stroke (>6 months post stroke), ability to perform a single-leg lunge on the paretic lower limb onto a stool from a standing position, ability to walk without an assistive device for more than 10 m, limited DF-PROM with contracture of the paretic ankle, and capability of following simple verbal instructions.

The exclusion criteria were significant visual impairment, unilateral neglect, and aphasia. We also excluded patients who presented with contraindications for joint mobilization (i.e., ankle joint hypermobility, trauma, or inflammation), ankle sprain in the previous 6 weeks, any history of ankle surgery, and those concurrently receiving similar interventions outside of the present study. All participants read and signed an informed consent document approved by the Research Ethics Board of Jeonju University and in accordance with the Declaration of Helsinki.

Intervention Procedures

Talocrural MWM, as described by Mulligan,[17] was administered by a physiotherapist with 10 years of experience. The participants were placed in a standing position facing the physiotherapist with the paretic limb placed on a stool (height: 30 cm). A nonelastic treatment belt was wrapped around the posterior part of the distal tibia of the patient and then anchored around the pelvis of the therapist. The patients actively moved into dorsiflexion by shifting their COG forward while the therapist simultaneously performed an anterior glide of the tibia using the treatment belt. For effective gliding, the talus and the forefoot were blocked by the therapist using the web space of the hand as close as possible to the anterior joint line. A grade 3 glide was sustained for 10 seconds during slow active dorsiflexion to the end of the pain-free range while maintaining the treatment belt perpendicular to the long axis of the tibia, and then released after returning to the starting position (Fig 2). Six sets of 10 repetitions were applied, with a 1-minute break between sets, as modified from previous studies.[18-20] Any participant with pain during treatment was excluded from the study. All participants received conventional physiotherapy for 30 minutes per session, 3 times per week for 5 weeks. The first 5 minutes of the passive and active ROM exercise were allotted for the paretic lower limb. And the next 15 minutes were spent on weight-bearing training during sitting and standing. The final 10 minutes were spent on functional training including walking and climbing stairs. Participants in the MWM group received an additional 30 minutes of treatment for MWM.

Outcome Measures and Data Analysis

The activities of daily living (ADLs) were assessed using the Korean version of the Modified Barthel Index (K-MBI). The K-MBI consists of 10 individual items regarding ADL and the degree of independence of the participants. The maximal score was 100, indicating that the participant was fully independent in ADL. The reliability and validity of the K-MBI are well established.[21] And

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