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ORIGINAL ARTICLE

Effects of Mobilization and Tactile Stimulation on Chronic Upper-Limb Sensorimotor Dysfunction After Stroke

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Abstract

Objective: To explore the effects of Mobilization and Tactile Stimulation (MTS) and patterns of recovery in chronic stroke (>12mo) when upper limb (UL) "performance" has reached a clear plateau.

Design: Replicated single-system experimental study with 8 single cases using A-B-A design (baseline-intervention-withdrawal phases); length of baseline randomly determined; intervention phase involved 6 weeks of daily MTS to the contralesional UL.

Setting: Community setting, within participants' place of residence.

Participants: Individual stroke survivors (N=8; male-to-female ratio, 3:1; age range, 49–76y; 4 with left hemiplegia, 4 with right hemiplegia) discharged from ongoing therapy, more than 1 year post stroke (range, 14–48mo). Clinical presentations were varied across the sample.

Interventions: Participants received up to 1 hour of daily (Monday to Friday) treatment with MTS to the UL for 6 weeks during the intervention (B) phase.

Main Outcome Measures: Motor function (Action Research Arm Test [ARAT]) and motor impairment (Motricity Index [MI] arm section) of the UL.

Results: UL performance was stable during baseline for all participants. On visual analysis, improvements in motor impairment were seen in all participants, and clinically significant improvements in motor function were seen in 4 of 8 participants during the intervention phase. Latency between onset of intervention and improvement ranged from 5 to 31 days (ARAT) and from 0 to 28 days (MI). Improvements in performance were maintained on withdrawal of the intervention. Randomization tests were not significant.

Conclusions: MTS appears to improve UL motor impairment and functional activity many months, even years, after stroke onset. Improvement can be immediate, but more often there is latency between the start of intervention and improvement; recovery can be distal to proximal.

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Worldwide, 15 million people per annum have a stroke, of whom 5 million die and another 5 million have permanent disability.[1] Further, stroke is the largest cause of major disability in the United Kingdom (UK).[1] Upper limb (UL) dysfunction is a leading cause of loss of independence in stroke survivors.[2] Rehabilitation for the hemiplegic UL is frequently short-term and limited by resources that tend to be focused on regaining balance and mobility so as to enable a more general functional recovery.[3] Most recovery is reported to take place in the first 3 months after stroke,[4] and patients with severe UL dysfunction are unlikely to recover high levels of manipulative skills[5-7] useful for functional ability. Long-term rehabilitation for stroke survivors is uncommon, particularly beyond 6 months; however, the neuroplasticity literature suggests that the potential for sensorimotor recovery from stroke can continue across the lifetime.[8]

Therapy for the hemiplegic UL is varied. Where there is voluntary motor activity, approaches to treatment that involve repetition and practice of functional tasks, such as repetitive task training and the shaping activities involved in constraint-induced movement therapy,[9] have been shown to improve UL motor impairment and functional activity. However, these approaches are not suitable for the many stroke survivors who have insufficient voluntary motor activity in that limb. Similarly, there are a number of stroke survivors who may have sufficient voluntary motor activity, or some functional ability in the limb, but who do not use their UL spontaneously in function.[7] Hands-on therapeutic interventions, such as those used by most UK physiotherapists working in stroke, are complex therapeutic

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interventions, many of which have not been evaluated in robust trials.[10]

Mobilization and Tactile Stimulation (MTS) is a module of routine therapy currently used in clinical practice to treat the contralesional UL after stroke.[11] It is a complex hands-on therapeutic intervention[12] that has been identified by expert neurophysiotherapists in the UK as a part of routine therapy. While not a novel intervention, MTS is a discrete module of therapy that has been modeled, described clearly, and its content summarized in a published treatment schedule,[11] and generalizability of this standardized schedule has been established (S.M. Hunter, PhD, unpublished data, January 2013). MTS involves hands-on sensorimotor stimulation to the forearm and hand.[13] Physiotherapeutic techniques, such as passive and accessory movements, cutaneous stimulation and proprioceptive feedback, active-assisted and active movement, and facilitation or guiding of functional patterns of movement, are individual components of MTS and are delivered in an appropriate combination. The selection of such an appropriate combination is based on the clinical reasoning of a skilled therapist according to patient presentation.[11]

A proof-of-principle phase I study[12] of MTS demonstrated potential benefits of MTS in improving motor impairment (measured by the Motricity Index [MI] arm section) and functional ability (measured by the Action Research Arm Test [ARAT]) in the contralesional UL.[14] A subsequent randomized, single-blind, phase I dose-modeling trial of MTS recommended a dose of 60 minutes daily in preference to a dose of 30 minutes, 120 minutes, or no MTS, in addition to a program of routine therapy.[13]

The potential effect of MTS appears to be one of priming[13] the sensorimotor system for activity through sensory stimulation; mobilization of joints, soft tissues, and body segments provides proprioceptive stimulation, and cutaneous stimulation provides tactile, mechanical (pressure, stretch), and proprioceptive stimulation through mechanoreceptors in the glabrous (nonhairy) skin of the hand.[15] Thus, the rationale is one of priming and/or augmenting activity in the motor execution system to facilitate the voluntary contraction of paretic muscle.[13]

Part of the modeling process[12,16] involves the identification of appropriate target groups. While evidence suggests that MTS may be effective in subacute stroke,[11,14] other subgroups of stroke survivors may also benefit. The aim of this study, therefore, was to explore the effects of MTS in chronic stroke (>12mo) when UL performance had reached a clear plateau.

Methods

We used an exploratory, replicated, single-system, A-B-A randomized, multiple baseline design (also known as randomized n-of-1 design[16]) to identify individual responses to MTS over time in stroke survivors living with a dysfunctional contralesional UL. Single-system experimental design has been described as an accepted and appropriate means of evaluating clinical change.[17-19]

List of abbreviations:

ARAT	**Action Research Arm Test**
MI	**Motricity Index**
MRC	**Medical Research Council**
MTS	**Mobilization and Tactile Stimulation**
UK	**United Kingdom**
UL	**upper limb**

Direct replication of a single-system experiment that follows a predictable pattern and produces the same result on at least 3 or 4 occasions is strong evidence of a causal relationship.[18,20] Moreover, the accumulation of results across participants strongly increases the generalizability of the findings.[18]

Ethics

The North Staffordshire Health Authority Local Research Ethics Committee granted approval for this study.

Inclusion and exclusion criteria

We included adult stroke survivors, men and women 18 years or older (no upper age limit), if they (1) had observable contralesional UL dysfunction of at least 12 months' duration; (2) had been discharged from ongoing therapy; and (3) were able to follow a simple 1-stage command using the nonparetic UL (eg, "place your hand on your head"), suggesting sufficient cognitive and communication ability to understand the study and to give consent. We excluded patients who had UL dysfunction caused by other pathologic disorders unrelated to stroke (eg, musculoskeletal disorders of the shoulder girdle), as this could confound treatment response, and those with any unstable medical condition.

We used a purposive sampling strategy to ensure an equal number of left and right hemisphere lesions.

We recruited participants from the follow-up stroke clinic at a local hospital, and invited additional volunteers from local stroke support groups to contact us if they wanted to participate. At the start and end of the study, for the purpose of generating potential hypotheses for future studies, we recorded individual Barthel Index[21] scores as an indication of independence in activities of daily living, and individual Star Cancellation Test[22] scores, to screen for unilateral spatial neglect. While a score of <44 is indicative of unilateral sensory neglect in an older population,[23] the score for the Star Cancellation Test was not used as a threshold for exclusion.

Outcome measures

We used the following outcome measures daily throughout all phases of the study to record performance:

- The MI has been reported to be a valid and reliable measure of motor impairment after stroke.[24,25] It is sensitive to change and has high correlation with dynamometry.[26] For the arm section, participants should be seated upright,[27] and an assessment of power and active range of movement is made in the 3 subsections of pinch grip, elbow flexion, and shoulder abduction. Scoring is based on the Medical Research Council (MRC) grades for muscle power, but weighted scores are used.[27] Ordinal scores for each subsection are summated, giving interval-level scores for the limb. Weighted scores for each subsection range from 0 to 33 (rather than 0−5 in the MRC scale). Table 1 details the scoring criteria.
- The ARAT[28] is a performance test measuring gross motor function and prehension. It is sensitive,[29] valid,[30] and reliable.[28,31] The overall test is divided into 4 subsections: grasp, grip, pinch, and gross motor skills. Each subsection is scored individually to provide an ordinal-level score. Subsection scores are summated to give a maximum score for the limb, providing