ACRM AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2015;96:2137-44

ORIGINAL RESEARCH

Proximal Fugl-Meyer Assessment Scores Predict Clinically Important Upper Limb Improvement After 3 Stroke Rehabilitative Interventions

Ya-yun Lee, PhD, PT,[a,b,*] Yu-wei Hsieh, PhD, OT,[a,b,*] Ching-yi Wu, ScD, OTR,[a,b] Keh-chung Lin, ScD, OTR,[c] Chih-kuang Chen, MD[d,e]

From the [a]Department of Occupational Therapy and Graduate Institute of Behavioral Sciences, College of Medicine, and [b]Healthy Aging Research Center, Chang Gung University, Taoyuan; [c]School of Occupational Therapy, College of Medicine, National Taiwan University, Taipei; [d]Department of Physical Medicine and Rehabilitation, Chang Gung Memorial Hospital at Taoyuan, Taoyuan; and [e]School of Medicine, Chang Gung University, Taoyuan, Taiwan.

[*]Lee and Hsieh contributed equally to this work.

Abstract

Objective: To identify the baseline motor characteristics of the patients who responded to 3 prominent intervention programs.

Design: Observational cohort study.

Setting: Outpatient rehabilitation clinics.

Participants: Individuals with chronic stroke (N=174).

Interventions: Participants received 30 hours of constraint-induced movement therapy (CIMT), robot-assisted therapy, or mirror therapy (MT).

Main Outcome Measures: The primary outcome measure was the change score of the Upper Extremity Fugl-Meyer Assessment (UE-FMA). The potential predicting variables were baseline proximal, distal, and total UE-FMA and Action Research Arm Test scores. We combined polynomial regression analyses and the minimal clinically important difference to stratify the patients as responders and nonresponders for each intervention approach.

Results: Baseline proximal UE-FMA scores significantly predicted clinically important improvement on the primary outcome measure after all 3 interventions. Participants with baseline proximal UE-FMA scores of approximately <30 benefited significantly from CIMT and robot-assisted therapy, whereas participants with scores between 21 and 35 demonstrated significant improvement after MT. Baseline distal and total UE-FMA and Action Research Arm Test scores could also predict upper limb improvement after CIMT and MT, but not after robot-assisted therapy.

Conclusions: This study could inform clinicians about the selection of suitable rehabilitation approaches to help patients achieve clinically meaningful improvement in upper extremity function.

Archives of Physical Medicine and Rehabilitation 2015;96:2137-44

Stroke is a leading cause of disability that affects millions of people worldwide.[1] More than 60% of stroke survivors have upper extremity (UE) impairment that strongly influences their activities of daily living and quality of life.[2] Several innovative interventions have been developed in the past 2 decades to reduce UE motor deficits and enhance functional abilities after stroke. Among these contemporary intensive rehabilitation approaches, constraint-induced movement therapy (CIMT), robot-assisted therapy, and mirror therapy (MT) are the 3 emerging interventions that improve UE motor recovery significantly in patients with stroke.[3-8] Constraint-induced movement therapy, one of the most popular rehabilitation approaches, was developed with the aim to overcome the learned nonuse phenomenon by immobilizing the nonparetic UE and forcing use of the paretic UE to perform functional tasks.[4,9-11] Robot-assisted therapy is an

Supported in part by the National Health Research Institutes (grant no. NHRI-EX103-10010PI), the Ministry of Science and Technology (grant nos. MOST 103-2314-B-182-002, MOST 103-2314-B-182-004-MY3, and MOST 102-2314-B-002-154-MY2), the Healthy Aging Research Center of Chang Gung University (grant nos. EMRPD1D0291 and CMRPD1B0331), and the Chang Gung Memorial Hospital (grant no. CMRPD 1C0402).

Disclosures: none.

0003-9993/15/$36 - see front matter © 2015 by the American Congress of Rehabilitation Medicine

http://dx.doi.org/10.1016/j.apmr.2015.07.019

intensive training approach with high repetition of guided movements, and strong evidence showed that highly repetitive practice is an active ingredient for significant motor recovery.[12,13] Systematic reviews[8,14-16] showed that the visual feedback and bilateral arm movement during MT have significant benefits for patients with UE impairment and function as well as activities of daily living. Despite the effectiveness of these interventions, there is discussion pertaining to which patient population could benefit the most from what therapy.[17]

Research studies[18] that aim to determine the specific characteristics of patients who respond to each therapy may further facilitate clinicians to target the appropriate patient population for rehabilitation. A systematic review[19] summarized that baseline UE motor impairment, functional abilities, and neurophysiological measures are the most important prognostic factors for UE recovery after rehabilitation. Neurophysiological measures, such as activation of ipsilesional primary motor cortex[20] or presence of motor evoked potentials,[21] are important predictors of motor and functional outcomes after task-oriented UE training. However, accurate neurophysiological measures rely on high technology devices, which might not be accessible in every clinic. Therefore, clinical methods that assess motor impairment and functional performance are more feasible to predict UE recovery after stroke.

Baseline motor impairment, as measured by active finger extension and the Upper Extremity Fugl-Meyer Assessment (UE-FMA), was found to significantly predict UE functional improvement after CIMT.[10,22,23] The Action Research Arm Test (ARAT), a measurement of paretic arm function, also predicted improvement in daily activities after CIMT.[24] As for robot-assisted therapy, poststudy observations suggested that participants with a baseline UE-FMA score between 20 and 55 demonstrated greater improvement in sensorimotor function than did those with scores of >55 or <20.[25] To our knowledge, no studies have investigated the baseline motor characteristics of patients with stroke who benefit from MT.

Owing to the wide range of prognostic variables and outcome measures used across studies, it is difficult to draw a consensus and identify the common variable(s) that can determine which intervention approach may be more beneficial for the motor or functional recovery of a given patient admitted to the clinic. The overall goal of this study was to determine a common clinical measure that can effectively identify patients with chronic stroke for each intervention approach (ie, CIMT, robot-assisted therapy, and MT).

Methods

Participants

This study was a secondary analysis of data from 174 individuals diagnosed with stroke who were involved in multiple intervention programs from previous randomized controlled trials[12,26-28] and in ongoing projects. The participants were recruited from multiple clinical settings and had similar characteristics (eg, disease severity and years after stroke). Of these participants, 56 received CIMT-based intervention, 54 received robot-assisted therapy–based intervention, and 64 received MT-based intervention. They signed an informed consent approved by the local review boards before participating in the studies. The participants had a first unilateral stroke, time since stroke onset >6 months, a baseline UE-FMA score of >16, ability to follow instructions to perform motor tasks, and no other neurological disorders.

List of abbreviations:

ARAT	**Action Research Arm Test**
CIMT	**constraint-induced movement therapy**
FMA	**Fugl-Meyer Assessment**
MCID	**minimal clinically important difference**
MG	**mesh glove**
MT	**mirror therapy**
UE	**upper extremity**
UE-FMA	**Upper Extremity Fugl-Meyer Assessment**

Treatment interventions

All participants received 30 hours of training distributed across 3 to 4 weeks. Participants in the CIMT-based intervention group received individualized 2-hour training sessions, 5d/wk for 3 weeks, focused on the functional training of the paretic UE. During therapy, the nonparetic UE was restrained with a mitt while the participants practiced functional tasks with their paretic limb. The functional tasks were selected on the basis of daily activities, such as carrying a full cup of water or using a hairbrush to comb hair. Besides the 2-hour training in clinics, the nonparetic UE was confined in the mitt for another 5 to 6 hours at home. Of the 56 participants in the CIMT-based intervention group, 20 (35.71%) practiced CIMT with trunk restraint whereas the other 36 (64.29%) did not have trunk restraint during therapy. The participants with trunk restraint wore a harness that secured them to the back of the chair to reduce potential compensatory movements from the trunk. Preliminary analysis revealed no significant group differences in UE-FMA improvement after these 2 types of CIMT, supporting the merging of the data.

The participants in the robot-assisted therapy–based intervention group received 1.5-hour training sessions, 5d/wk for 4 weeks. The participants practiced forearm pronation-supination and wrist flexion-extension with the Bi-Manu-Track[a] robotic system.[29] Twenty-five participants (46.30%) practiced bilateral arm movements in 3 modes: passive-passive, active-passive, and active-active. In the passive-passive mode, both arms were guided passively by the robot arm. In the active-passive mode, the nonparetic arm actively moved the robot handle whereas the paretic arm was passively guided by the device. In the active-active mode, both arms performed active movements, with resistance provided by the robot. The other 29 participants (53.70%) received unilateral paretic UE practice with modified training modes: passively moved by the device, actively moved the handle without resistance, and moved the handle against a preset resistance. After 70 to 80 minutes of robot-assisted therapy, all participants received 10 to 20 minutes of functional task training to facilitate transfer of the acquired motor ability to daily activities. No significant differences were noted in UE-FMA improvement between bilateral and unilateral robot-assisted therapy interventions; thus, the data of these 2 approaches were merged.

For the MT-based intervention, the participants were trained for 1.5-h/session, 5d/wk for 4 weeks. Within each session, the participants received 60 minutes of MT with a wooden mirror box and 30 minutes of functional task training. During MT, the participants performed intransitive and transitive movements with the nonparetic hand and were required to imagine that the mirror reflection of the nonparetic hand was the paretic hand performing the movements. Simultaneously, the participants were encouraged to move their paretic hand along with the nonparetic hand.[26] Of