ORIGINAL ARTICLE

Effect of Baseline Spastic Hemiparesis on Recovery of Upper-Limb Function Following Botulinum Toxin Type A Injections and Postinjection Therapy

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ABSTRACT. Chang C-L, Munin MC, Skidmore ER, Niyonkuru C, Huber LM, Weber DJ. Effect of baseline spastic hemiparesis on recovery of upper-limb function following botulinum toxin type A injections and postinjection therapy. Arch Phys Med Rehabil 2009;90:1462-8.

Objective: To determine whether baseline hand spastic hemiparesis assessed by the Chedoke-McMaster Assessment influences functional improvement after botulinum toxin type A (BTX-A) injections and postinjection therapy.

Design: Prospective cohort study.

Setting: Outpatient spasticity clinic.

Participants: Participants (N=14) with spastic hemiparesis divided into 2 groups: Chedoke-McMaster Assessment Hand-Higher Function (stage≥4, n=5) and Chedoke-McMaster Assessment Hand-Lower Function (stage=2 or 3, n=9).

Interventions: Upper-limb BTX-A injections followed by 6 weeks of postinjection therapy.

Main Outcome Measures: Primary outcomes were Motor Activity Log-28 and Motor Activity Log items. Secondary outcomes were Action Research Arm Test (ARAT), Motor Activity Log-Self-Report, and Modified Ashworth Scale (MAS). Measures were assessed at baseline (preinjection), 6 weeks, 9 weeks, and 12 weeks postinjection.

Results: Primary and secondary outcomes improved significantly over time in both groups. Although no significant differences in ARAT or MAS change scores were noted between groups, Chedoke-McMaster Assessment Hand-Higher Function group demonstrated greater change on Motor Activity Log-28 (P=.013) from baseline to 6 weeks and Motor Activity Log items (P=.006) from baseline to 12 weeks compared to Chedoke-McMaster Assessment Hand-Lower Function group.

Conclusions: BTX-A injections and postinjection therapy improved hand function and reduced spasticity for both Chedoke-McMaster Assessment Hand-Higher Function and Chedoke-McMaster Assessment Hand-Lower Function groups. Clinicians should expect to see larger gains for persons with less baseline impairment.

Key Words: Botulinum toxin type A; Electric stimulation therapy; Muscle spasticity; Recovery of function; Rehabilitation; Stroke; Upper extremity.

SPASTIC HEMIPARESIS IS A common and severely disabling condition after stroke and traumatic brain injury. Approximately 55% to 85% of persons with acute or chronic hemiparesis have restricted upper-extremity function.[1,2] Impaired hand function due to spastic hemiparesis limits functional use of the hand for critical tasks, such as drinking a glass of water, opening a door, and controlling the steering wheel while driving a car. Thus, quality of life is severely compromised by spastic hemiparesis.

Clinicians and researchers have effectively used activity-based rehabilitation interventions[3-10] to promote motor improvement after central nervous system injury. However, severe spastic hemiparesis may prevent people from engaging in activity-based rehabilitation interventions that are necessary to restore motor function. As a result, these therapies have only been proven to be effective in persons with mild hemiparesis and generally little or no spasticity.[11]

To enable people with severe symptoms to participate effectively in activity-based therapies, rehabilitation interventions should include additional treatments to reduce spasticity. BTX-A has been shown to relieve spasticity in persons with upper limb spasticity.[12-16] Although BTX-A is effective in reducing severe spasticity, some investigators noted this reduction favors significant improvements in hand function, whereas others disagree.[17-19] Nevertheless, our clinical experience suggests that BTX-A injections and postinjection therapy can improve hand function in many persons with spastic hemiparesis.

One explanation for these varied results may be due to differences in severity of baseline hand impairment. Presently there are several thoughts as to whether baseline hand impairment impacts functional recovery during rehabilitation. One hypothesis is that persons with mild baseline hand impairment attain more functional recovery after targeted interventions compared to those with severe baseline hand impairment. Some have even suggested that intensive rehabilitation inter-

List of Abbreviations

ARAT	Action Research Arm Test
BTX-A	botulinum toxin type A
CMA	Chedoke-McMaster Assessment
FES	functional electrical stimulation
MAS	Modified Ashworth Scale

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Table 1: Chedoke McMaster Assessment Hand Impairment Scale: Stage 2 to 5 of Recovery of Hand

Stage	Chedoke McMaster Assessment
2	Positive Hoffman sign
	Resistance to passive wrist or finger extension
	Facilitated finger flexion
3	Wrist extension more than one-half range
	Finger/wrist flexion more than one-half range
	Supination, thumb in extension: thumb to index finger
4	Finger extension, then flexion
	Thumb extension more than one half range, then lateral prehension
	Finger flexion with lateral prehension
5	Finger flexion, then extension
	Pronation: finger abduction
	Hand unsupported: opposition of thumb to little finger

Data from: Gowland et al.[23]

ventions for upper-limb impairment should not be offered to those with severe impairment because the possibility of recovery is low.[20] An alternative hypothesis is that persons with severe baseline hand impairment sustain greater functional recovery than persons with mild baseline hand impairment because persons with mild baseline hand impairment have less potential gain to achieve. A third hypothesis is that baseline hand impairment does not influence the amount of functional recovery after BTX-A injections and postinjection therapy.

The purpose of this study was to determine whether baseline hand impairment assessed by the CMA influences functional improvement after BTX-A injections and 6 weeks of standardized postinjection therapy. In contrast to focusing on impacts of severity of hand paresis after acute stroke in persons without spasticity (flaccid upper limb),[21] we examined persons with severe spasticity after chronic stroke because they were less likely to show significant functional changes through traditional rehabilitation care. Understanding the role of baseline hand impairment that can be easily assessed in a clinical setting will be useful for predicting functional outcomes for people with spastic hemiparesis.

METHODS

Participants

A convenience sample was recruited from the Department of Physical Medicine and Rehabilitation Spasticity Clinic at the University of Pittsburgh. People who had unilateral spastic hemiparesis for a minimum of 6 months and had at least 2 prior sessions of BTX-A for spasticity treatment were eligible for participation. This prior exposure confirmed that participants tolerated injection therapy without adverse reactions with a predictable dosage. All participants had their most recent botulinum toxin injection at least 3 months before study participation. We selected a 3-month washout period based on the work of de Paiva et al,[22] who reported that the motor endplate where botulinum toxin was injected regained its function fully after 3 months and was indistinguishable from endplates where toxin was not injected.

All participants had preinjection Modified Ashworth scores of 2 or more in at least one of the following muscle groups: elbow, wrist, or finger flexors. In addition, all participants had to attain at minimum a stage 2 on the CMA Hand Impairment Scale, plus demonstrate the ability to complete at least one of the tasks that met criteria for stage 3 (table 1). Stage 2 on the CMA includes at least 2 of 3 items: positive Hoffman sign, resistance to passive wrist or finger extension, and facilitated finger flexion. These criteria defined participants with minimal residual hand function and excluded those who had no voluntary motion. Participants with CMA scores of 3, 4, and 5 were also included. All participants were able to answer questions and follow instructions; they did not have severe, fixed joint contracture in the affected arm. Persons who met the screening criteria were provided additional information regarding the study, and, if they were interested, they provided informed consent. All procedures were approved by the university's institutional review board.

Measures

Baseline hand impairment was assessed with the 7-point CMA.[23] The CMA is reliable and valid[23]; it determines the presence and severity of physical impairments in the hand. For the purposes of this study, we divided the cohort into 2 groups based on their CMA Hand Impairment Scale score (table 2). Participants with a CMA score of stage 4 or higher were classified as high functioning (CMA Hand-Higher Function) and participants with a CMA Hand-Higher Function and score of stage 2 or 3 were classified as low functioning (CMA Hand-Lower Function).

Primary outcomes were upper-extremity function during activities of daily living assessed observationally by Motor Activity Log-28 and Motor Activity Log-5 items (wash hands, dry hands, pick up a phone, operate a doorknob, and pick up a glass). The Motor Activity Log-28[24] is a tool that assesses hand function with daily tasks. For the purpose of this study, we used the "How Well Scale" of the Motor Activity Log-28. The 5 items were selected before participants enrolled in the study and were based on our expectations that the interventions would show improvement in at least these tasks. We selected 5 activities that focused specifically on hand function (compared with arm function) because we focused on testing the changes in hand function. The 5 items were selected from 28 items in the Motor Activity Log, which has reliability and validity. Secondary outcomes were (1) dexterous hand function as measured by the ARAT,[25,26] (2) participant's perception of self-performance in activities of daily living assessed with the

Table 2: Participant Demographics and Clinical Characteristics

Group	CMA Hand-Lower Function (n=9)	CMA Hand-Higher Function (n=5)
Age (y)	44.4±13.3	45.6±12.2
Type of stroke	Thrombotic (n=4; 45%), TBI (n=3; 33%), other (n=2; 22%)	Thrombotic (n=3; 60%), other (n=2; 40%)
Side of lesion	Left (n=6; 67%), right (n=3; 33%)	Left (n=2; 40%), right (n=3; 60%)
Area of stroke	Cortical (n=9; 100%)	Cortical (n=4; 80%), subcortical (n=1; 20%)
Years since onset	5.9±1.9	15.2±9.1
Total BTX-A dose (units)	303.9±121.0	290.3±117.0

NOTE: Values are mean ± SD or as otherwise indicated.
Abbreviation: TBI, traumatic brain injury.