Assessment of the Ipsilesional Hand Function in Stroke Survivors: The Effect of Lesion Side

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Background: The aim of this study was to examine the effect of the side of brain lesion on the ipsilesional hand function of stroke survivors. *Methods:* Twenty-four chronic stroke survivors, equally allocated in 2 groups according to the side of brain lesion (right or left), and 12 sex- and age-matched healthy controls performed the Jebsen-Taylor Hand Function Test (JTHFT), the Nine-Hole Peg Test (9HPT), the maximum power grip strength ($PwGS_{max}$) test, and the maximum pinch grip strength ($PnGS_{max}$) test. Only the ipsilesional hand of the stroke survivors and both hands (left and right) of the controls were assessed. *Results:* PwGS max and PnGS max were similar among all tested groups. Performances in JTHFT and 9HPT were affected by the brain injury. Individuals with left brain damage showed better performance in 9HPT than individuals with right brain damage, but performance in JTHFT was similar. *Conclusions:* Individuals after a brain injury have the capacity to produce maximum strength preserved when using their ipsilesional hand. However, the dexterity of their hands and digits is affected, in particular for stroke individuals with right brain lesion. **Key Words:** Cerebrovascular accident—dexterity—manipulation—fingers—force.

Introduction

Structural changes in the central nervous system caused by a cerebrovascular accident or stroke may result in loss of hand function. Recent studies have indicated that the upper extremity ipsilateral to the cerebral lesion (ipsilesional) presents sensorimotor alterations that impair the outcome of movements requiring accurateness.[1-5] Conversely, a study showed that the ipsilesional maximum power grip strength ($PwGS_{max}$) is similar to the one produced by healthy controls.[5] Therefore, it has been suggested that ipsilesional sensorimotor deficits of stroke individuals are not related to muscle force generation, but to the ability to control and coordinate their upper limb muscles.[5,6]

The ipsilesional upper limb sensorimotor deficits may depend on which brain hemisphere is injured. Tretriluxana et al observed that individuals who had a stroke in their right brain hemisphere had greater difficulty in transporting their ipsilesional hands in space when compared with individuals who had an injury in the left hemisphere, taking longer to accomplish a reach-to-grasp task.[7] Similarly, stroke individuals with a right brain damage (RBD) present deficits in controlling their hand's final position,[1,3,8,9] which would affect the performance in tasks that require precision and fine hand control.

Few studies examined the effect of the side of brain lesion on hand and digits dexterity. For instance, Yelnik et al found no effect of the side of brain lesion on the performance of a digits dexterity test (Nine-Hole Peg Test [9HPT]) in individuals in the acute stage of stroke.[10] Similarly, Wetter et al found no difference between chronic stroke individuals with right and left brain damage (LBD) in a multitask hand dexterity test (Jebsen-Taylor Hand

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Received November 14, 2016; revision received January 29, 2017; accepted February 20, 2017.

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1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2017.02.023

Function Test [JTHFT]).[11] Therefore, the effect of the side of the brain injury on the hand function of the ipsilesional side of chronic stroke individuals is still underexplored. To provide more knowledge in this important topic, we tested 3 hypotheses with this study: (1) chronic stroke individuals when using their ipsilesional hand and healthy controls would produce similar magnitudes of $PwGS_{max}$ and maximum pinch grip strength ($PnGS_{max}$); (2) the performance in tests requiring digits and hand dexterity would be worse in the ipsilesional hand of chronic stroke individuals than in the healthy controls; and (3) individuals with RBD would have worse digits and hand dexterity than individuals with LBD when using the ipsilesional hand.

The understanding of the effect of the side of brain lesion on hand and digits dexterity and strength could be very useful for clinicians and therapists to comprehend how the side of brain lesion affects the sensorimotor and functional performance of the ipsilesional, "less affected," upper extremity of stroke individuals. This could be very important to promote appropriate rehabilitation protocol for the ipsilesional hand, which assumes most of the function executed by the contralesional hand after a stroke event.

Method

Participants

Thirty-six right-handed adults were allocated into 3 groups: individuals with RBD (n = 12), individuals with LBD (n = 12), and healthy individuals (controls, n = 12) matched by age, sex, body mass, and stature with stroke individuals. The participants signed an informed consent form. Both the experimental procedures used in this study and the informed consent form were approved by the local human research ethics committee.

Inclusion and Exclusion Criteria

Participants from the RBD and the LBD groups were recruited among patients of 2 physical therapy clinics from universities located in São Paulo (Brazil), and participants from the control group were recruited in the local community. One hundred and fifty stroke individuals were previously selected from both clinics' patient list, contacted in person or via telephone, questioned about the stroke episode, and then preliminarily evaluated to detect other neurological diseases and cognitive deficits.

To be included in the sample, the participants with brain injury should have had unilateral ischemic stroke in the anterior or middle cerebral arteries territory occurring between 6 months and 10 years preceding the date of testing and should present hemiparesis on the side contralateral to the brain lesion. Participants who had other neurological impairment, known peripheral sensory changes, complaints of dizziness, pain, and cognitive change that would undermine the understanding of verbal commands were not included in the sample. Healthy individuals should not present any musculoskeletal, neurological, or cognitive problems to be included in the sample.

Experimental Procedures

Initially, questions about participant's sociodemographic characteristics and about the brain injury episode and its consequences were asked. Next, participants were requested to answer questions about handedness.[12] Afterward, the participants with brain damage were assessed regarding the degree of sensorimotor impairment of their contralesional upper extremity by the Fugl-Meyer Assessment of the Upper Extremity (FMA-UE).[13,14]

Then, participants' hand and digits dexterity and $PwGS_{max}$ and $PnGS_{max}$ were tested. Hand dexterity was assessed by individuals' performance in the JTHFT (Model 8063, Sammons Preston, Bolingbrook, IL, USA). Digits dexterity was evaluated by the 9HPT (Rolyan Nine-Hole Peg Test, Model A8515, Sammons Preston, Bolingbrook, IL, USA). $PwGS_{max}$ was tested by using a Jamar hydraulic hand dynamometer (Sammons Preston, Bolingbrook, IL, USA) and $PnGS_{max}$ was assessed by a pinch grip hydraulic dynamometer (SAEHAN, SH5005, Changwon, South Korea). JTHFT and 9HPT were performed first in a balanced order. Afterward, grip strength tests were performed, also in a balanced order. Participants from the RBD and the LBD group performed all tests using only their ipsilesional hand (right hand for RBD and left hand for LBD). Participants from the control group performed all tests with their right and left hand and the order was also balanced, with half of the participants starting with their right and half starting with their left hands. Participants did not receive any practice before the tests. Only for the 9HPT, participants performed a single trial for familiarization following its standardized instructions.

Participants were assessed in 6 of the 7 subtests of the JTHFT: (1) simulated page turning, (2) lifting small objects, (3) simulated feeding, (4) stacking blocks, (5) lifting large and lightweight objects, and (6) lifting large and heavyweight objects. The writing subtest was not applied because the participants were not English native speakers and because it is already known that writing performance could be affected by the language brain center, which is located at the left brain hemisphere.[15,16] Participants were asked to perform each subtest as fast as possible. The time to complete each subtest was recorded by a digital stopwatch. According to the JTHFT's standardized procedure, the participants performed a single trial of each subtest. However, in cases in which participants were unable to complete 1 of the subtests (e.g., dropping any test object on the ground), the subtest was repeated afterward. The participants' performance in the JTHFT was defined by the sum of the performance times in all 6 subtests.

The 9HPT was performed in a plastic rectangular console containing a concave circular container in which 9 small cylindrical pegs (6.4 mm in diameter and 32 mm in length)