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Reliability of maximal grip strength measurements and grip strength recovery following a stroke

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ABSTRACT

Study design: Clinical measurement.
Purpose: The test-retest reliability of maximal grip strength measurements (MGSM) is examined in subjects for 12 weeks post-stroke together with maximal grip strength recovery and the maximal-grip and upper-extremity strength measurements' relationship with capacity and performance test scores.
Methods: A Jamar dynamometer and the Motricity Index (MI) were used for strength measurements. The Chedoke Arm and Hand Activity Inventory and ABILHAND questionnaire for evaluating capacities and performances.
Results: MGSM were reliable (Intraclass Correlation Coefficients = 0.97–0.99, Minimal Detectable Differences = 2.73–4.68 kg). Among the 34 participants, 47% did not have a measurable grip strength one week post-stroke but 50% of these recovered some strength within the first eight weeks. The MGSM and MI scores were correlated with scores of tests of capacity and performance (Spearman's Rank Correlation Coefficients = 0.69–0.94).
Conclusions: MGSM are reliable in the first weeks after a stroke.
Level of evidence: N/A.

Introduction

In 2010, approximately 750,000 people in the United States had a new or recurrent stroke.[1] Among the survivors, a majority have experienced a long-term disability.[2] Hemiparesis is present in most subjects and has a negative impact on activities and participation.[3]

Maximal grip strength is easy to measure and is commonly used in clinical practice to quantify weakness and recovery following a stroke.[4,5] The reliability of maximal grip strength measurements has been demonstrated both in asymptomatic and symptomatic subjects.[6,7] Studies have also shown that maximal grip strength measurements are reliable in subjects with hemiparesis.[8–12] However, none of these studies was conducted with this population specifically in acute or sub-acute phases following stroke in spite of the clinical relevance of grip strength measurements during these phases to document the early evolution of upper-extremity paralysis or paresis. It could be hypothesized that these measurements are not reliable in the acute or post-acute phase due to fatigue, incoordination or the low range of strength values.

Maximal grip strength measurement is a simple and appropriate method of characterizing the upper-extremity weakness as it is correlated with elbow flexion and shoulder abduction strength.[13] Sunderland et al[14] have reported that grip strength measurements and Motricity Index (MI) scores[15,16] at one month post-stroke are good predictors of the capacity of the paretic upper extremity to perform tasks (i.e., Frenchay Arm Test) at six months. They also showed that, although the MI is more sensitive to detect early recovery, grip strength measurements have higher sensitivity for showing later improvement.

Many other studies have shown that initial upper-extremity strength after a stroke, along with upper-extremity functional movements and neurophysiological factors, are good predictors

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of the upper-extremity recovery.[17,18] The follow-up period varies considerably between studies, from two weeks to over two years but studies report a limited number of repeated assessment sessions shortly after stroke, thus limiting the appreciation of initial strength recovery. In addition, the measurements of upper-extremity recovery used are often related to impairments with very few assessing activity and even fewer exploring participation as defined by the International Classification of Functioning, Disability and Health (ICF).[17–19] From a clinical point of view, it would be important to know to what extent early grip strength and grip strength recovery are related to early and long-term capacity and use of the upper extremity in daily activities. As Foley et al[20] noted, there is a debate about prognostic factors determining which subjects should have intensive therapy rather than learning compensatory techniques. If grip and upper-extremity strength measurements in the early stages after a stroke are reliable and can give an indication about the future evolution of capacity and performance, it could help to estimate the prognostic and choose the adequate therapeutic approaches.

Purpose

The primary aim of this study was to establish the test-retest reliability of maximal grip strength measurements of both hands in subjects with hemiparesis in the first 12 weeks post-stroke. The secondary aims were to examine maximal grip strength recovery in the first 12 weeks post-stroke and to estimate the relationships between maximal grip and upper-extremity strength measurements and results of tests that measure capacity and performance.

Methods

Participants

Subjects were recruited from a consecutive sample of people admitted to a neurology ward after a first stroke between March 2011 and September 2013. Subjects were included if they 1) had a diagnosis of ischemic or hemorrhagic stroke confirmed by CT or MRI, 2) were aged between 18 and 80 years, 3) had an upper-extremity paresis (all grades of severity, proximal or distal, with and without somatosensory deficit or hypertonia), 4) had a stable medical condition allowing participation in usual rehabilitation therapies such as occupational therapy and physical therapy, 5) were candidates to enter a specialized rehabilitation program for neurological disabilities in a university hospital rehabilitation ward or in an external neuro-rehabilitation hospital. Subjects were excluded if they 1) had an orthopedic or neurological condition affecting the upper-extremity performance already prior to the stroke and 2) were unable to understand simple instructions (i.e., had severe comprehensive aphasia).

The local ethics committee (Commission cantonale VD d'éthique de la recherche sur l'être humain) approved this study (protocol 197/10) and all participants gave informed consent prior to their participation.

Procedure and instruments

The data collection was performed in three different hospital settings. All participants were recruited in an acute neurology ward of a university hospital (setting 1) where they stayed on average 11 days before they moved to the university hospital rehabilitation ward (setting 2) or an external rehabilitation hospital (setting 3) to enter a specialized rehabilitation program for neurological disabilities. Participants who had returned home before the 12th week post-stroke completed the assessment sessions as outpatients.

All participants were assessed nine times over a 12-week period. The initial assessment session was done one week post-stroke (mean of 7.68 and SD of 1.82 days). Subsequently, pairs of assessment sessions, separated by one or two days, were conducted at two, four, eight and 12 weeks post-stroke (mean (SD) days of 14.5 (1.6), 28.4 (1.9), 56.7 (2.7) and 85.5 (2.3) respectively). The order of the measurements was standardized and is presented in Table 1. The assessors were occupational therapists employed by the participating hospitals. They were provided with a 10-h training session on the assessment tools.

Motricity Index

The upper-extremity strength was assessed by three movements from the upper-extremity section of the MI by Collin and Wade[16] (pinch grip, elbow flexion and shoulder abduction). Each movement is rated with a weighted score giving a total score ranging from 0 (no palpable contraction) to 99 (normal pinch grip and normal power). One point may be added to the total score allowing a maximal score of 100. The inter-rater reliability of the upper-extremity section of the MI was shown to be good in one study.[16]

Maximal grip strength

The maximal grip strength was measured with a hydraulic Jamar hand dynamometer™ (Model *5030J1,* Sammons Preston Rolyan, Bolingbrook, USA). The procedure proposed by the American Hand Therapy Association[21] was followed. The participants were seated with the arm in adduction, the elbow flexed at 90°, the forearm in the neutral position and the wrist between 0 and 30 degrees of extension. The second handle position was used as per standard protocol. Three consecutive trials were performed with each hand, beginning with the non paretic side. The mean of the three trials was kept for the analyses.

For this study, three new Jamar dynamometers were used, one in each of the three clinical settings. We checked their calibration before the first use, after the first and the second years of use, and upon the completion of the data collection. We followed the method proposed by Fess[22] using known weights with a cumulative load up to 60 kg. At each calibration check, all coefficients of correlation between weights and readings were over 0.9995 for all three dynamometers. For two dynamometers on two occasions, there was a difference between the values of the weights and the readings. These differences, namely 1.0 kg, −0.75 kg, −0.46 kg and −1.0 kg, resulted from a slight displacement of the needle, which did not remain exactly in the center of the zero mark. As the zero mark on the dial of the dynamometers is quite large, small displacements are not obvious to spot for the assessors. At each calibration check, the needle was repositioned with the calibration screw if needed. This did not affect the reproducibility of the

Table 1
Schedule of assessment sessions

	MI	MGS	CAHAI	ABIL
Week 1	x	x		
Week 2 (1)	x	x		
Week 2 (2)		x	x	
Week 4 (1)	x	x		
Week 4 (2)		x	x	
Week 8 (1)	x	x		
Week 8 (2)		x	x	
Week 12 (1)	x	x		x
Week 12 (2)		x	x	

MI: Motricity Index; MGS: Maximal grip strength; CAHAI: Chedoke Arm and Hand Activity Inventory; ABIL: ABILHAND questionnaire.