

Comparison of methods of measurement of grip strength by dynamometer and modified manual sphygmomanometer of middle middle cerebral artery stroke patients

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Abstract - Grip strength is an important indicator of an individual's hand function and is tested in different hand and wrist disorders and even in other conditions that grossly affect the strength of the muscles. One of the pathologies that greatly affects grip strength is the middle cerebral artery (MCA) stroke. Stroke is a sudden loss of neurologic functions caused by an interruption of the blood flow to the brain. It is the leading cause of disability with residual neurologic deficits that persistently impair functions. Different tools in grip strength testing can be used such as hand dynamometers and alternatively, a modified sphygmomanometer. This study compared the validity and reproducibility of modified sphygmomanometer with hand dynamometer in grip strength measurement among status post-MCA stroke patients using an experimental research design. Thirty individuals with post-MCA stroke of both genders (male, 73.30% and females, 26.70%), aged 25 to 80 (mean \pm SD of 58.17) were included in the study. Pearson product moment correlation coefficient test and Cronbach's Alpha were used to analyze the data. Results revealed that both hand-held dynamometer and modified sphygmomanometer have a high reliability index of 0.80 in terms of measuring grip strength of post-MCA stroke. Either of the two instruments can be used to assess the baseline and post-treatment measure for hand grip in post-MCA stroke. However, the results cannot be interpolated for the modified sphygmomanometer and hand-held dynamometer since there is no correlation in the grip strength measurements for the two instruments.

Keywords - grip strength, hand dynamometer, sphygmomanometer, middle cerebral artery stroke

INTRODUCTION

Among stroke patients, up to 10% experiences middle cerebral artery (MCA) occlusion (Cornu et al., 2000; Moulin et al., 1985; Silver et al., 1984). It occurs in cases of ischemic stroke among Asians, Hispanics and Blacks (Lee et al., 2005; Caplan et al., 1986; Wong et al., 1998). Specifically, the infarcts are ascribed to embolism of the heart or the internal carotid artery (ICA), poor perfusion due to ICA occlusion, intrinsic MCA occlusive disease, or intrinsic disease in the lenticulostriate penetrating vessels (Min et al., 2000).

In a previous study by Sunderland (2000), it was shown that after one month of parietal or frontal damage after MCA stroke, the ipsilateral hand showed impaired dexterity with slowing and clumsiness. Clinically, among stroke patients ipsilesional arm are often referred as "unaffected" but researches proved otherwise (Sunderland et al., 1999). Regardless of which hemisphere is affected,

it was found that lift-to-grasp and grasp-lift movements are affected in both lateralities (Nowak, 2007). However, persons whose dominant hand was affected demonstrate better motor function, such as grip strength than those whose non dominant hand was affected (Harris et al., 2006). Following hemiparesis, arm use is influenced by hand dominance (Rinehart et al., 2008) which is correlated with increased facility of preferred hand (Elliot et al., 2000; Mieschke, 2001). In right-handed subjects, previous studies suggested that the dominant hand has greater grip strength but no such differences between sides were recorded for left-handed people (Koley et al., 2009; Incel et al., 2002).

Hand grip strength is an easily available evaluation of physical health and muscle function primarily hand and forearm muscles and is tested by determining the maximal hand grip force that can be delivered (Boadella et al., 2005). Reliable and valid measurement of hand strength is needed to determine the effectiveness of various treatment and intervention procedures (Dhara et al., 2009; Muralidhar and Bishu, 2000).

The measurement of hand grip strength requires the use of dynamometers. Computerized dynamometers calculate functional grip (Baguley et al., 2010). Hand-held mechanical dynamometers, which have excellent inter-rater and test-retest reliability, quantify the maximal grip strength achieved during a phase of exertion (Innes, 1999).

In 2004, Lucareli and colleagues reported the suitability of modified sphygmomanometer in the measurement of hand grip strength in a normal population. Modified sphygmomanometer is economical, portable, simple and easy to use in evaluation. It is an alternative instrument, although it is not very popular in clinical practice and it needs to be calibrated before each measurement to achieve valid results (Lucareli et al., 2010). The suitability of using a modified sphygmomanometer in assessing the hand grip strength of patients with clinical conditions however is in question because previous studies (Lucareli et al., 2010; Koley et al., 2009) utilized only a normal subset of participants.

It is widely established that patients with clinical conditions have varied responses to treatment. As such, instruments used to assess such conditions must be studied thoroughly to determine their applicability, accuracy and precision. In this regard, this study seeks to establish the suitability of a modified sphygmomanometer in the assessment of hand grip strength among patients with MCA stroke with the end view of seeking an inexpensive assessment method of hand grip strength in patients with the said condition.

MATERIALS AND METHOD

Participants

A total of 30 participants (Delgado et al., 2004) were purposively recruited from the Rehabilitation Department of Mary Mediatrix Medical Center, Lipa City to participate in this study. They were asked to sign an informed

consent form. The ethical approval for the use of human subjects in this study was sought from the Research Committee of the College of Allied Medical Professions of Lyceum of the Philippine University and from the Ethical Review Board of the Mary Mediatrix Medical Center. Only patients with status post middle cerebral artery stroke right hemiparetic, right handed (Koley et al., 2009; Incel et al., 2002) and at least in the stage three of hand recovery (Brunstomm, 1970) were included in this study.

Design

The goal of this study is to test the validity of modified sphygmomanometer in measuring the grip strength among patients with status post MCA stroke. The study utilized a comparative research design with quasi experimental approach.

Instruments

The materials that were used are modified sphygmomanometer seen in Fig. 1 (Delgado et al., 2009) and Jamarhand-held dynamometer seen in Fig. 2. The inflatable cuff of the aneroid sphygmomanometer was rolled and taped.



Fig. 1. Modified sphygmomanometer



Fig. 2. Hand- held dynamometer

Procedure

After the approval of the research proposal, the participants underwent hand grip strength measurement using the modified sphygmomanometer and hand-held dynamometer by a singly blinded examiner trained to carry out the tests. They were instructed to sit in a straight-backed chair with shoulders adducted in neutral, arms unsupported and elbows flexed at 90° and forearm in neutral and wrist $0-30^{\circ}$ dorsiflexed and $0-15^{\circ}$ ulnarly deviated (Richards and Palmiter-Thomas, 1996; Ashton and Myers, 2004). The instruments were set to zero before each test and placed on the volunteer's hand. The participants were asked to grasp (palmar closure) the hand-held dynamometer and/or modified sphygmomanometer with a maximal force upon the instruction of the examiner (Lucareli et al., 2010). The test was repeated three times for the right hand with a 60-second interval between each procedure. The mean value was used in the analysis of data (Richards and Palmiter-Thomas, 1996; Ashton and Myers, 2004).

Statistical Tool

The profiles of the participants were analyzed using frequency and percentage. Cronbach's Alpha and Pearson Correlation Coefficient were used to determine the index of comparability between the two methods.

RESULTS

Table 1
Percentage Distribution of the Participant's Profile

Profile Variables	Frequency	Percentage (%)
Sex		
Male	22	73.30
Female	8	26.70
Age		
25 – 34 years old	1	3.30
35 – 44 years old	1	3.30
45 – 54 years old	5	16.70
55 – 64 years old	13	43.30
65 – 74 years old	8	26.70
75 years old and above	2	6.70
Mean ± SD	58.17	10.80

Table 1 shows the percentage distribution of the participants' profile variables. Most of the participants are male with 22 or 73.30% and only 8 or 26.70% are females.

Majority of the participants belongs to 55 – 64 years old age bracket with 13 or 43.30% age bracket of 65 – 74 has 8 or 26.70%, then by 45 – 54 years with 5 or 16.70%. This is followed by 75 years and above has 2 or 6.70% and lastly 25 – 34 and 35 - 44 years, both has 1 or 3.30%. These findings correlate with previous studies reporting the high prevalence of stroke among male and elderly patients.

Table 2
Mean and Standard Deviation in three grip strength using modified sphygmomanometer and hand-held dynamometer

Trial	1	2	3	Mean
Modified Sphygmomanometer (mmHg)				
Mean	50.27	51.53	53.07	51.51
Standard Deviation	14.85	16.60	16.53	15.84
Hand-held Dynamometer (kg)				
Mean	5.00	5.43	5.50	5.31
Standard Deviation	3.34	3.38	3.50	3.25

Table 2 shows the mean and standard deviation of both instruments. For modified sphygmomanometer, the mean average is 51.51 with standard deviation of 15.84 and for hand-held dynamometer the mean average is 5.31 with standard deviation of 3.25. This implies that the data for hand-held dynamometer are closer to the mean unlike the result in the modified sphygmomanometer in which the data are scattered and far from the mean. It also implies that the highest and lowest scores can be found in modified sphygmomanometer. This indicates that there is a normal distribution of data for hand-held dynamometer.

The Pearson product moment correlation coefficient test for each possible pair of the modified sphygmomanometer and hand-held dynamometer readings collected all over the trials are presented in Table 3. The average r for the three trials was 0.945 for the sphygmomanometer and 0.860 for dynamometer, each with a statistically significant relationship (p -value < 0.01) for scores obtained between the three trials intervals. This implies that the assessment of grip strength among post-MCA stroke patient varies between the two instruments and indicates the lack of correlation between the two methods of measurement. The results therefore are not comparable and cannot be interpolated.

Table 3
Correlation Coefficient between Two Instruments

Part 1	Sphy 1 vs. Sphy 2	$r = 0.936$; p -value < 0.01
	Sphy 1 vs. Sphy 3	$r = 0.931$; p -value < 0.01
	Sphy 2 vs. Sphy 3	$r = 0.969$; p -value < 0.01
	Dyna 1 vs. Dyna 2	$r = 0.830$; p -value < 0.01
	Dyna 1 vs. Dyna 3	$r = 0.846$; p -value < 0.01
	Dyna 2 vs. Dyna 3	$r = 0.936$; p -value < 0.01
Part 2	Sphy 1 vs. Dyna 1	$r = 0.668$; p -value < 0.01
	Sphy 2 vs. Dyna 2	$r = 0.723$; p -value < 0.01
	Sphy 3 vs. Dyna 3	$r = 0.768$; p -value < 0.01
Mean score of Sphy vs. Mean scores of Dyna		$r = 0.740$; p -value < 0.01

Table 4
Reliability Results of the Trials Conducted for the Two Instruments

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
(Modified Sphygmomanometer) 0.980	0.981	3
(Hand – held Dynamometer) 0.949	0.949	3

Table 4 shows the results for reliability of the trials conducted for both modified sphygmomanometer and hand-held dynamometer. Cronbach's Alpha was used, for modified sphygmomanometer resulted to 0.980 and for hand-held dynamometer is 0.949. Results demonstrated high within instruments repeated measures reliability and anacceptable correlation between modified sphygmomanometer and hand-held dynamometer grip strength testing were similar, each yielding correlation values of 0.80 or greater.

DISCUSSION

Hand grip strength measurement is an important factor for hand rehabilitation especially for those who suffered MCA strokes. It assesses the patients' initial limitation or it serves as a baseline and provides a rapid reassessment of patient's progress throughout the treatment. Stroke is one of the neurologic conditions that greatly affect the grip of the patient (Incel et al., 2002).

This study investigated the reliability and validity of using two different instruments namely the hand-held dynamometer and the modified sphygmomanometer in MCA stroke patients with right hand being affected. Hand-held dynamometer is a standardized instrument used in measuring grip strength of normal individuals and there are studies(Lucareli et al., 2010; Koley et al., 2009)that involve measuring grip strength with the use of sphygmomanometer on the same population. Participants are sitting comfortably and instructed to grip the sphygmomanometer and/or the dynamometer as hard as they can. Three trials for both instruments were done with 60 seconds interval for each trial.

Through this study, the investigators found out that both the hand-held dynamometer and the modified sphygmomanometer are both reliable and can be used in acquiring the grip strength for those affected hand grips such as for MCA stroke patients. However, the investigators also found out that there is no significant relationship between the modified sphygmomanometer and hand-held dynamometer. The study made by Lucareli (2010) concluded that

sphygmomanometer is reliable and a good method in measuring grip strength for normal population and that both the hand-held dynamometer and the modified sphygmomanometer have no significant relationship.

CONCLUSIONS

This study revealed that both the hand-held dynamometer and modified sphygmomanometer have a high reliability index in terms of measuring the grip strength of MCA stroke patients. Either of the two measurements can be used to assess baseline and post-treatment measure of grip strength. Furthermore, this study also revealed that there is no correlation in the grip strength measurements between the two instruments. This implies that although both instruments are reliable in measuring grip strength, their results cannot be interpolated based on repeated measures for the modified sphygmomanometer and hand-held dynamometer.

RECOMMENDATIONS

Based on the findings and conclusions the researchers recommend the following:

1. To increase the number of participants, including not only MCA patients in MMMC but also to all rehabilitation centers in Batangas Province.
2. To also increase the trials for repeated measure for better outcome of the study.
3. To investigate other conditions with affected grip strength not only stroke.
4. To use hand dynamometer in measuring grip strength for validity
5. To test if the sphygmomanometer can be used as a strengthening exercise for those with weak grip.

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