

Correlation between Motor Evoked Potentials and Upper Extremity Functional Outcome Measures in Chronic Stroke: A Cross Sectional Study

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ABSTRACT

Objectives: Stroke is one of the most neurological diseases that causes upper extremity impairment. In order to set an individualized treatment program for these impairments, it may be crucial to use and determine the association between the different assessment tools of upper extremity function. The aim of our study was to evaluate any correlation of Motor evoked potentials with the Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) and the Wolf Motor Function Test (WMFT) in patients with chronic stroke. **Methods:** Forty chronic ischemic stroke patients, aged 45 to 60 were included. Wolf Motor Function Test and Fugl-Meyer Assessment of the Upper Extremity and Suprathreshold Motor Evoked Potentials (sMEPs) were measured for all patients. **Results:** A significant positive correlation among FMA-UE and sMEPs ($r = 0.346$, $p = 0.028$) was found. There was no significant relation between WMFT and sMEPs ($r = 0.034$, $p = 0.834$). **Conclusion:** sMEPs was found to be related with FMA-UE scale and can be a good indicator for functional impairment level in chronic stroke patients.

Keywords: Stroke, Motor Evoked potentials, Wolf Motor Functional Test, Fugl-Meyer Assessment of the Upper Extremity

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INTRODUCTION

Stroke negatively affects upper limb and hand functions. Upper limb motor impairments were reported in about 75% of stroke survivors [1]. These impairments can adversely affect quality of life (QoL), psychological state, return to work and social integration of the stroke patients [2]. This is because the upper extremities have a major impact in functional independence of stroke patients. Accurate and objective measurement tools are needed to assess these impairments and their consequences on stroke patients [3]. Consequently, it is crucial to perform a research work that investigate the correlation between different assessment measures of upper extremity function post stroke. This can help in evaluating and expecting stroke patients' prognosis and improvement after different treatment modalities.

The Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) is among the most frequently utilized scales for assessing upper extremity motor impairment after stroke. It shows excellent reliability and accuracy in both research and clinical settings [4]. The Wolf Motor

Function Test (WMFT) is a validated and timed measurement tool of upper extremity functional abilities post stroke. It highly emphasizes on task performance in stroke patients suffering from moderate and severe upper extremity impairment [5]. Transcranial Magnetic Stimulation-induced Motor Evoked Potentials can objectively assess corticospinal tract integrity following stroke. They can be utilized as an accurate predictor of upper limb motor recovery following stroke [6]. However, few studies investigated the association of Motor Evoked potentials (MEPs) with functional outcomes measures in stroke patients especially the Wolf Motor Function Test (WMFT) [7-10].

Therefore, the current study provides an accurate neurophysiological assessment and its relation with the most frequently used scales in stroke. It also provides a neuronal connection and underlying mechanism with the clinical improvement seen in stroke patients. Our study included different populations' characteristics and settings compared with previous studies. This study was done to examine any association between MEPs and functional outcome measures, including FMA-UE and WMFT.

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MATERIALS AND METHODS:

Setting:

The study was performed in the period from February 2025 to September 2025 at El Zahir Physiotherapy Center, Egypt. All patients were given a thorough explanation of the study's goals and methods before it began. prior to the study, all of the patients signed a written consent form. The research was given approval by the Faculty of Physical Therapy's Ethics Committee for Clinical Research at Cairo University (P.T.REC/012/005711). Pan African Clinical Trial Registry ID: PACTR202505804979619 was also used to record our trial.

Participants:

A total of 40 patients represented the current study. Baseline patients' characteristics, including their inclusion and exclusion criteria have been reported previously in another study currently under peer review. Patients were recruited from El Zahir Physiotherapy Center, Egypt. Patients with chronic ischemic stroke, from both sexes, their age from 45 to 60 years old, represented this study. The exclusion criteria included any musculoskeletal or neurological disease, except stroke, causing upper extremity impairment, recurrent stroke, metallic implants or previous history of seizure.

Outcomes Measures:

Suprathreshold motor evoked potentials (sMEPs), FMA-UE and WMFT were assessed for all patients.

The Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) was utilized for measurement of the upper extremity motor function, including movement, coordination and reflex through 33 items on a 3-point scale. The normal score of FMA-UE is 66 points. Lower scores represent higher upper limb impairment [11].

The Wolf Motor Function Test (WMFT) was used to assess the functional performance of upper extremity through 15 tasks on a timed 6- point scale. The tasks included timed joint-segment activities and integrated functional activities. Each participant was asked to perform each task as rapid as he can, with a maximal duration of 120 seconds [12].

The suprathreshold motor evoked potential (sMEPs) was utilized to evaluate the corticospinal tract excitability by Transcranial Magnetic Stimulation which produced by Magstim standard rapid² stimulator (Magstim company, Whiteland, Wales, UK). The Magstim was connected to Electromyography machine (Nihon Kohden, Neuropack X1, EMG/EP MEB-2300, Japan). Surface electrodes were used to record the motor evoked potentials from the first interosseous muscle (FDI). The sMEPs was obtained and analyzed [13].

Statistical Analysis

Data analysis:

Prior to analysis, the data were checked for statistical assumptions. Normality was evaluated using the Shapiro-Wilk test. The homogeneity of variance was determined using Levene's test. Outliers were defined as values that were more than 1.5 times the interquartile range. After that, we used Shapiro-Wilk to verify that the WMFT, FMA-UE, and sMEPs followed a normal distribution (P-value > 0.05). The homogeneity of variance assumption was found to be significantly violated (P-value < 0.05) according to Levene's test. Parametric analyses were considered suitable for the primary outcomes as normality was fulfilled. Use of SPSS (Version 25.0; IBM Corp., Armonk, NY) was required for all statistical methods. The groups were compared utilizing an un paired samples *t*-test, as well as the demographic data (age, weight, height, BMI) are shown as mean ± standard deviation. The relationships between WMFT scores and sMEPs parameter and between FMA-UE scores and sMEPs parameter were examined using Pearson's correlation coefficient. The alpha level for statistical significance was set at 0.05 for all tests.

RESULTS

Patient Characteristics:

The demographic data of all participants are displayed in table (1). The average age Some of the patients' demographic data have been reported previously in another study currently under peer review.

Table 1: Demographic data of all participants in both groups:

Variable	Mean ±SD
Age (year)	53.37 ±4.53
Height (cm)	166.07 ±4.04
Weight (kg)	74.82 ±5.98
BMI (Kg/cm ²)	27.18 ±2.61

SD: Standard deviation; cm: centimeter, Kg: kilogram

Relation of sMEPs variable with WMFT and FMA-UE:

The bi-variate correlation coefficients were computed between WMFT and FMA-UE with sMEPs variable for all patients in Table (2).

There was moderate significant positive relation between FMA-UE with sMEPs (r = 0.346, p = 0.028) (Figure 1).

There was non significant positive correlation between WMFT with sMEPs (r = 0.034, p = 0.834) (Table 2).

Table 2: Relation of sMEPs variable with WMFT and FMA-UE for all patients:

Variable	sMEPs
FMA-UE	r value: 0.346 P value: 0.028*
WMFT	r value: 0.034 P value: 0.834

r: Pearson correlation coefficient; P: probability value; *Significant: ($P < 0.05$); Strong correlation (± 0.50 to ± 1); Moderate correlation (± 0.30 to ± 0.49); Low correlation ($< \pm 0.29$)

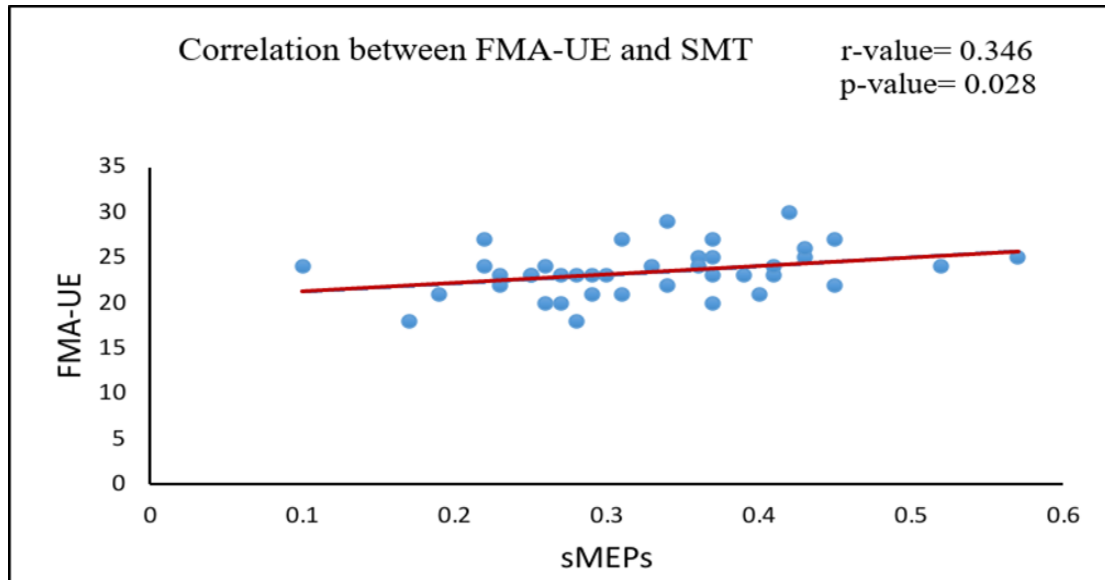


Figure (1): scattered plot relation of sMEPs variable with FMA-UE for all patients

DISCUSSION

This study was done to assess any relation among the MEPs variable (sMEPs) and the most used functional scales (FMA-UE and WMFT) in chronic stroke patients.

The main finding of our study was the presence of a significant positive correlation between FMA-UE and sMEPs ($p < 0.05$). TMS- induced suprathreshold MEPs (sMEPs) reflects corticospinal tract (CST) integrity. Suprathreshold MEPs can recruit high-threshold motor units and intracortical circuit. It can differentiate between conduction block from reduced membrane excitability. Absent or low-amplitude sMEPs indicates CST disruption and failure of neural conduction. While high sMEPs implies preserved CST and neural plasticity, presented as higher scores of functional performance scales like FMA-UE. So, our study supports this finding. Our result was in line with previous studies which revealed a positive correlation between FMA-UE and MEPs variables in chronic and subacute stroke patients [7,8].

A non-significant positive correlation was detected among WMFT and sMEPs in the current study. Up to our knowledge, this is the first study to assess the correlation between WMFT with any MEPs variable. The WMFT asses upper extremity function through different aspects from FMA-UE in stroke patients. The WMFT can mainly assess patient’s task performance level [14]. While the

FMA-UE measures the patient’s motor impairment level [15]. According to our results, the sMEPs can be used a strong assessment tool for upper extremity impairment level not for task performance level in chronic stroke patients. Our findings also support the superiority of FMA-UE on WMFT for measuring upper extremity motor function in stroke patients [16].

Study Limitations:

There are some limitations of the present study. Only one MEPs parameter was evaluated and correlated with functional scales in the current study. Also, the limited sample size of our study restricts the generalization of the findings. Future studies with larger sample size should include more MEPs parameters to be assessed and correlated with functional scales.

Conclusion

The present study showed a moderate association between one of the most used clinical scales like the FMA-UE and the neurophysiological variable (sMEPs) in chronic stroke patients.

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Author Contributions:

Rania Mamdoud and Shreen Ibrahim Taha: Conceptualization and Methodology, Marwa Mostafa: writing and editing, Hoda M. Zakaria, Ebtessam M.Fahmy and Mostafa M. ElKholy: data analysis, Visualization and

editing. All authors read and confirmed the final manuscript.

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