Original Article

Validity of Modified Ashworth Scale as a Measure of Wrist Spasticity in Stroke Patients

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Objective: There are some controversies about the value of modified Ashworth Scale (MAS) for assessing spasticity. The goal of this study was to investigate if there is any correlation between scores obtained from MAS for wrist spasticity and electrophysiological recordings as the objective measure of spasticity.

Methods: In this cross-sectional study, 34 stroke patients were employed. Wrist spasticity was clinically measured by means of MAS. Also, an electromyogram (EMG) machine was used to elicit Hmax and Mmax from the flexor carpi radialis muscle. Spearman's correlation coefficient test was used to investigate potential correlation between clinically and electrophysiologically measures of spasticity.

Results: The observed relation between MAS and EMG recordings was not statistically significant (rho=0.183 P>0.05).

Discussion: Our findings suggest that MAS may be a useful tool for grading hypertonia, but it is not a valid measure of spasticity in selected patients.

Keywords: Validity, Modified Ashworth Scale, Spasticity, Stroke

Introduction

Spasticity has been defined as a motor disorder characterized by a velocity-dependent increase in tonic stretch reflexes with exaggerated tendon jerk resulting from hyperexcitability of the stretch reflex, as one component of the upper motor neuron (UMN) syndrome (1). According to some recent studies, spasticity can lead to motor dysfunction and limitation of activity after stroke (2-4). Thus, managing of spasticity should be considered as a part of rehabilitation plan (5) and it is obvious that proper measurement is necessary for adequate results (6). Currently, various methods are used for measuring spasticity that generally categorized into three groups including: biomechanical, neurophysiological and clinical tools which none of them have widely acceptance (6-11).

Although Modified Ashworth Scale (MAS) is likely most common tool for assessing spasticity both in research and clinical practice, its methodological limitations are now increasingly being addressed (6, 7, 12, 13]. One of these limitations is lack of a standardized method for assessing spasticity (6, 11). For example some clinicians assess limb spasticity from the rest position without any previous limb stretching while others move the limb several times in the flexion-extension pattern before the assessment have been done. Therefore, this difference in performing test may interfere with the results because the excitability of the stretch reflex maybe different in two conditions (6). Another discussable issue about MAS is that, it is not obviously determined that it should be considered as an ordinal or a nominal scale for assessment of spasticity because of the grade 1^+ added to five-grade original Ashworth scale (7, 13).

Although, it is suggested that most of the limitations of the MAS can be overcome especially at the wrist joint, as it has been reported high inter and intra rater reliability of MAS for wrist spasticity in some

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studies (9, 14, 15), some authors still claim that MAS can not be a valid tool for assessing spasticity because of low ability of this scale for discriminating spasticity from the other factors contribute to hypertonia (mostly biomechanical changes in involved muscles) seen after central neurological damages include stroke (12, 15, 16). In addition, during the test examiner needs to rapidly move a particular joint and simultaneously and subjectively determine the amount of resistance to passive stretch (7).

However, it seems to be reasonable the weaknesses be ignored if the MAS be correlated meaningfully to an objective measure of spasticity (6). The ratio of maximum amplitudes of H reflex and its muscle response (Hmax/Mmax) is a parameter of electromyography (EMG) which used as a neurophysiological measure of spasticity (1, 9, 12, 17). Although this measurement is expensive and time-consuming and thus has not wide acceptance (14), it remains as a valuable tool for validation of some clinical scales like MAS (6). Despite some studies around validity of MAS have reported good relationship between data obtained from this scale and EMG results (18, 19), but others equally suggested that poor to moderate correlation exists between them (14). In summary, previous studies are inconclusive and it seems that additional studies is required (11, 13). In this study we investigated the relationship between scores obtained from MAS and EMG recordings to measure wrist spasticity in stroke patients.

Methods

In this cross-sectional study, 34 stroke patients were selected randomly from those referred to outpatient Rehabilitation Centers of University of Social Welfare and Rehabilitation Sciences (USWRS), Tehran, between August 2008 and April 2009. All participants signed a consent form, approved by Ethic Committee of USWRS, before the study.

Participants

Following criteria were set for the sample: presence of post-stroke hemiplegia occurred at least six month before the study, detectable spasticity in involved wrist (0<MAS<4), without fixed joint contracture and skin problems in the involved upper extremity and lack of BONT-A injection during 6 month before the study. Both clinical and neurophysiological assessments of the spasticity were made at the same session in the similar condition.

The modified Ashworth scale

Wrist spasticity was assessed by means of MAS. This six-fold scale range from 0 (no spasticity) to 4 (fixed muscle contracture) based on the amount of muscle resistance perceived by the examiner in response to passive stretch of particular joint (See table 1). To diminish inter–rater variability of the scale, all subjects were tested by the same person. Resistance to passive muscle stretch was measured at the involved wrist while the subjects have sat on the chair and their involved arm rest on a pillow placed on their leg. For all subjects, wrist stretch was started from the full flexion position without any repeated flexion/extension movement before the test was done.

Table1. Modified Ashworth Scale for grading spasticity

score	description
0	no increase in muscle tone
1	slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when theaffected part(s) is moved in flexion or extension
1^+	slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	more marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	considerable increase in muscle tone, passive movement difficult
4	affected part(s) rigid in flexion or extension

H_{max} /M_{max} ratio

Surface EMG machine was used to elicit H_{max}/M_{max} ratio from *the Flexor Carpi Radialis (FCR)* using bipolar, pregelled circular (diameter 10 mm) electrodes. Two electrodes were placed on the belly of the FCR and in the *Cubital Fossa* (to stimulate the median nerve) whit 3 cm distance between them. The band-pass filter was set at 2 and 10 KHz (12). According to previous studies, median nerve was stimulated with a rectangular electrical pulse of 1 ms duration and with stimulus frequency of 1 per five seconds (9). The stimulus intensity was increased gradually until H_{max} and M_{max} were obtained. The pick to pick form of amplitudes of H and M waves were recorded as H_{max} and M_{max} respectively. To avoid variability of H_{max}/M_{max} ratio due to different degree of muscle contraction, all tests were performed at the rest position of wrist and full supination of forearm.

Data analysis

Statistical calculations and analysis were performed with the software package SPSS for windows, version 16.0.

Based on a recent comprehensive review about MAS, it should be treated as a nominal scale for assessing spasticity (15). Therefore, to investigate relation between MAS scores and EMG recordings, *spearman* correlation coefficient test was used. Statistical significance was set at level of $P< 0.05$.

Results

To investigate any potential correlation between MAS and H_{max}/M_{max} ratio scores, evaluated patients were divided into four groups based on their obtained scores from MAS which could be 1, 1^{+}, 2 or 3. Therefore, after all tests were performed, six patients were placed in group A (MAS=1), ten in group B (MAS=1^{+}), eleven in group C (MAS=2) and seven in group D (MAS=3). Among our samples, twenty-one had involvement of left side against thirteen who had right-side involvment. The ratio of male/female was 19/15. The mean and standard deviation of age and survival duration of participants were 59.5±7.41 and 15.8±4.47 respectively. Also, the distribution of sex, age, involved side and survival duration were statistically similar in four groups (P>0/05). These observations are shown in table 2.

Table2. The main demographic features of sample

group	age		Survival duration		sex		involvement	
	mean±std dev.	P-value	mean±std dev.	P-value	M/F	P-value	L/R	P-value
A	59.5±6.89	0.261	16.6±2.80	0.514	3/3	0.710	2/4	0.407
B	58.0±6.86		15.3±3.59		7/3		6/4	
C	63.0±7.16		17.0±5.68		6/5		8/3	
D	56.42±14.00		14.0±4.76		3/4		5/2	
total	59.5±7.41		15.8±4.47		19/15		21/13	

During the performing of EMG tests, the H reflex was not elicited in three cases; therefore, these cases were excluded from the analysis. The mean and standard deviation of H_{max}/M_{max} ratio in groups A, B, C and D were 17.1±2.98, 20.7±3.59, 21.3±4.56 and 19.9±1.50 respectively. Also, as shown in table3, the observed correlation between MAS and H_{max}/M_{max} ratio scores was not statistically significant (*rho*=0.183 P>0.05).

Table3. Correlation between MAS and H_{max}/M_{max} ratio scores

group	N	H_{max}/M_{max}	Spearman's rho	P-value
A	5	*17.1±2.98	0.183	0.323
B	10	20.7±3.59		
C	9	21.3±4.56		
D	7	19.9±1.50		
total	31	20.1±3.62		

*mean ± standard deviation

Discussion

This study was run to determine if there is any meaningful relationship between scores obtained from MAS and H_{max} /M_{max} ratio for measuring wrist spasticity in stroke patients; if so, the value of MAS as a clinical tool for measuring spasticity would be increased, because one of the main mechanisms of muscle spasticity is increased α motor neuron excitability (20-21). Also, the value of H_{max} /M_{max} ratio for measuring changed observed excitability of α motor neuron has been confirmed (22-24).

It has been found that the amount of H_{max} /M_{max} ratio will reach its maximum level in 2 to 6 months after central nervous system damage and then remain stable (25). So it was important to obtain H_{max} /M_{max} ratio at least six months after occurrence of stroke, as we performed. Also, according to some studies, reliability of MAS in upper limb is higher than lower limb especially in distal segments (9, 14, 26), thus we targeted the wrist joint for assessment to enhance the strength of the study.

However, we observed linear, but not meaningful, correlation between scores obtained from MAS scale and H_{max} /M_{max} ratio. Therefore, our results support previous studies regarding weakness of MAS as an exclusive measure of spasticity (1, 7, 14, 15).

Bakheit et. al believe that although most of limitations of the MAS can be overcome, its method of scoring the severity of hypertonia remains still controversial (6), because it depends on examiner's subjective judgment of the perceived degree of resistance against passive muscle stretch (6, 7). Moreover, some authors believe that increased resistance to passive stretch is primary due to an increased reflex response (14, 27), this resistance often reflects a combination of neural and structural components of hyoertonia (12, 28-31) which only one of them could be spasticity (32).

Another inherent problem of MAS in measuring spasticity maybe is lack of accounting velocity. Since the spasticity is naturally velocity-dependent and it is not certainly determined which stretch velocity should be applied when performing MAS, it is not possible to distinguish between spasticity and other factors contribute to hypertonia during the test (33).

Based on these findings, the MAS scores and amount of α-motor neuron excitability do not correlate together and thus, MAS is not a valid measure of spasticity. However it may still remain a helpful tool for some clinical purposes when the hypertonia rather than spasticity is the subject of measurement.

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