ORIGINAL REPORT

Comparison of Modified Ashworth Scale and Hoffmann Reflex in Study of Spasticity

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Abstract- Spasticity is one of the common complications in upper motor neuron lesions and without appropriate treatment it causes disturbances in movement pattern. Assessments of patients are effective in patient`s management. Modified Ashworth scale (MAS) is one of the criteria in qualitative assessment of spasticity, and there are lots of controversies about its validity. The purpose of this study is to compare MAS with electrophysiological indices of spasticity. The spasticity of upper limb muscles in patients with hemiplegic cerebral palsy are measured and recorded by MAS. Then electrophysiological indices of Hoffmann reflex (H reflex) and ratio of maximum range of action potential of combined movement of flexor carpi radialis (FCR) for upper limb and soleus for lower limb were estimated. Data of 11 patients with age range 4 to 6 were analyzed. There is no significant correlation between degree of spasticity and electrophysiological indices.

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Key words: Cerebral palsy; muscle spasticity; reflex, abnormal; motor neurons

Introduction

Spasticity is a type of movement disorder which is characterized by velocity dependent increase in tonic stretch reflex. Spasticity is caused by upper motor neuron lesion and is due to excessive excitability in stretch reflexes (1-4).

It involves movement production mechanism and causes stiffness and contracture (5, 6). Modified Ashworth scale (7, 8) is a test for evaluating muscle spasticity and recently is widely used for research purposes and clinical practice. This clinical test is based on resistance to joint passive movement. However, the validity of this scale for evaluating spasticity is the subject of doubt (9). Hoffmann reflex (H reflex) represents monosynaptic reflex and its range indicates degree of excitability of motor neuron (9).

Since spasticity caused by increased stimulation of alpha motor neuron, and H reflex indirectly measures spinal excitability this reflex is used to evaluate spasticity (9).

Patients and Methods

Eleven hemiplegic children aged 4 to 6 participated in this study and the study was approved by ethic committee of University of Social Welfare and Rehabilitation Sciences and parents of the participants provided informed written consent. The experiment was done in quiet rooms and temperature was between 24 to 26 degrees centigrade (10).

Modified Ashworth Scale (MAS)

Resistance to passive stretch of muscles in hemiplegic side was measured by modified Ashworth scale (MAS) in shoulder, elbow, and wrist. As table 1 shows this scale measures the muscle`s hypertonicity in the range of 0 to 4 (static muscle contracture 4, normal

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Table 1. Modified Ashworth Scale for Grading Spasticity

Grade	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 the affected 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

muscle tone 1). The patients tested in supine position. All tests were performed by single assessor in order to eliminate inter-rater variability (7, 9).

Latency of H reflex, H_{max}:M_{max} ratio

H reflex, and M wave were obtained by neuromapper EMG (USA) device. Patients were tested prone for lower limb reflexes (11) and supine for upper limb reflexes. Superficial silver chloride electrodes were placed by 2 centimeters in FCR in upper limb. Skin was cleaned so that the resistance was decreased to less than 10 kΩ, before applying the electrodes. Excitement of H reflex in FCR muscle was done through the median nerve stimulation in the medial anterior aspect of the elbow joint by the bipolar stainless electrodes. Stimulation period was 0.1 min second with the frequency of 0.2.

Band pass filter was set between 20 Hz to 3kHz and Hugon processing was applied (12). Reinforced signals were digitalized and stored in the computer hard disk to calculate H_{max}:M_{max} ratio and H reflex latency. Critically optimized median nerve stimulation position was determined initially to observe visible contraction of FCR muscle. Then the flow gradually got increased so that H reflex was recorded without M response. Response with maximum range was selected as H_{max} and other values were rejected. Then stimulation intensity was increased to obtain M response. H reflex with three phasic waves and initial small curve with subsequent large negative wave were detected. Bipolar stimulation was used on the desired nerve to prevent the effect on surrounding nerves (11).

Maximum range of H reflex and M wave were measured from positive peak to negative peak of the curve (11). H_{max} to M_{max} ratio calculated by division of the maximum range of H reflex to the maximum range of M wave. H reflex and M wave were obtained from soleus muscle so that superficial silver chloride electrodes were placed on the internal bump of the soleus muscle and posterior tibialis nerve got stimulated behind the knee .by increasing Stimulation gradually,maximum range of H reflex was recorded. Stimulation intensity increased so that maximum M response obtained and range, latency and wave recorded.

Results

Eleven spastic hemiplegic patients (7 girls, 4 boys) who fulfilled the study entery criteria completed the evaluation. Demographic and clinical data are given in the second table. Six patients were right hemiplegic and five were left hemiplegic.

Mean and standard deviation of patient age was 59/91 ± 9/15 (48 to 72) month. Range of score of MAS were 1 to 4. Range of mean values and standard deviation of latency of H reflex in upper limb were 12/69 ± 1/00 millisecond. Mean value and standard deviation of H_{max}:M_{max} of FCR were 0/22 ± 0/11. Mean value and standard deviation of H reflex latency of soleus muscle was 18/34 ± 1/19. Mean value and standard deviation of H_{max}:M_{max} ratio in lower limb were 0/30 ± 0/11 millisecond. There was no significant correlation between degree of spasticity measured by MAS and none of the neurologic indices (in other words latency of H reflex and H_{max}:M_{max} ratio in upper limb and lower limb). The software which was used, is SPSS 11/5.

Discussion

The aim of our study was to investigate the correlation between MAS scores and excitability of alpha motor neuron in subjects with spasticity by obtaining such a correlation, MAS validity as a clinical tool for evaluation of muscle spasticity increases. Because increased excitability in alpha motor neuron is an important mechanism of spasticity. Irritability of alpha motor neuron was assessed by measuring H reflex latency and H_{max}:M_{max} ratio. Sensitivity of this tests have already been confirmed (13-15).

Table 2. Patients' demographic and clinical data

Patient	Age/sex	Ashworth scale score MAS S	MAS E	MAS W	H reflex latency in upper extremity	$H_{max}:M_{max}$ in upper extremity	H reflex latency in lower extremity	$H_{max}:M_{max}$ in lower extremity
1	54/m	3	4	3	11.50	0.15	17.00	0.43
2	69/f	1	1	2	13.00	0.27	20.00	0.22
3	71/m	1	2	3	13.00	0.41	20.70	0.54
4	66/f	2	3	2	13.80	0.19	18.40	0.24
5	49/f	1	2	3	13.00	0.32	18.00	0.28
6	58/f	1	2	3	13.00	0.18	18.50	0.20
7	58/m	1	2	2	13.80	0.14	18.40	0.13
8	48/m	1	2	2	---	---	16.90	0.33
9	65/f	3	3	2	---	0.30	18.40	0.27
10	72/f	1	2	2	12.30	0.06	17.00	0.34
11	49/f	1	3	2	10.80	---	18.40	0.31
Sum	59/91±9/15 /--				12.69±1.00	0.22±0.11	18.34±1.19	0.30±0.11
	(48-72)	(1-3)	(1-4)	(2-3)	(10.80-13.80)	(0.06-0.41)	(16.90-20.70)	(0.13-0.54)

MASS, modified Ashworth scale in shoulder joint; MASE, modified Ashworth scale in elbow joint; MASW, modified Ashworth scale in wrist joint; m, male; f, female

As mentioned before H reflex is similar to stretch reflex in spinal cord. The other difference between these two reflexes is that: stretch reflex in spinal cord is produced after the muscle streching while the H reflex is the result of electrical stimulation. After an appropriate stimulation, action potential is moving to alpha motor neuron through the Iα afferents, and finally leads to sudden muscle contraction (11).

In order to increase the reliability of the experiences following points have been considered in the present study: both tests were performed in one session and in equal situation, factors influencing H reflex (for example head and limb position) and MAS test (for example bladder condition) were controlled (16).

In the study of Ghotbi et al (2007) it was shown that there is no significant correlation between MAS scores and $H_{max}:M_{max}$ ratio. They expressed that since the MAS rely on the evaluation of reflex activity by individual examiner, lack of correlation could be in connection with its inherent problems of this scale (16).

In the study by Bakheit and colleagues weak correlation between the neurophysiologic test results and degree of spasticity was found. They also expressed that inherent problems of MAS were the cause, because this scale is relied on the examiner mental judgment for measuring the resistance against passive stretch of muscle (9).

Despite the mentioned studies which claim that the shortcoming of the Ashworth scale is because of its inherent weakness however evidences suggest that resistance against passive movement is not significantly influenced by the reflex mediated neural activity unless the passive stretch velocity is high (4).

Reliability of Ashworth scale is better in upper limb (4) and therefore we have measured muscle tone in upper limb in this study. On the other hand, the possibility of lack of participation of children forced us not to measure Ashworth scale in lower limbs.

We conclude that also MAS may provide a valid scale of resistance against passive movement, according to Lance (1, 2): "it doesn't measure spasticity exclusively", and as Pandyan explains: by evidences it is assumed that resistance against movement depends on deferent factors (2). Our results also show that there is no correlation between MAS and electrophysiological indices, but it requires more studies to be performed on this topic.

References

1. Lance JW. Symposium synopsis. In: Feldman RG, Young RR, Koella WP, editors. Spasticity, Disordered Motor Control: Disordered Motor Control. Chicago: Year Book Medical, Symposia Specialists; 1980. p. 487-9.
2. Lance JW. Pathophysiology of spasticity and clinical experience with Baclofen. In: Lance JW, Feldman RG, Young RR, Koela WP, editors. Spasticity: disordered motor control. Chicago: Year Book Medical Publishers; 1980. p. 185-204.
3. Mayer NH. Clinicophysiologic concepts of spasticity and motor dysfunction in adults with an upper motoneuron lesion. Muscle Nerve Suppl 1997;6:S1-13.

4. Pandyan AD, Johnson GR, Price CI, Curless RH, Barnes MP, Rodgers H. A review of the properties and limitations of the Ashworth and modified Ashworth Scales as measures of spasticity. Clin Rehabil 1999;13(5):373-83.
5. Elovic EP, Simone LK, Zafonte R. Outcome assessment for spasticity management in the patient with traumatic brain injury: the state of the art. J Head Trauma Rehabil 2004;19(2):155-77.
6. Gormley ME Jr, O'Brien CF, Yablon SA. A clinical overview of treatment decisions in the management of spasticity. Muscle Nerve Suppl 1997;6:S14-20.
7. Ashworth B. Preliminary trial of carisoprodol in multiple sclerosis. Practitioner 1964; 192:540-2.
8. Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther 1987;67(2):206-7.
9. Bakheit AM, Maynard VA, Curnow J, Hudson N, Kodapala S. The relation between Ashworth scale scores and the excitability of the alpha motor neurones in patients with post-stroke muscle spasticity. J Neurol Neurosurg Psychiatry 2003;74(5):646-8.
10. Hiraoka K, Nagata A. Modulation of the Flexor Carpi Radialis H Reflex Induced by Cervical Traction. J Phys Ther Sci 1998;10(1):41-5.
11. Palmieri RM, Ingersoll CD, Hoffman MA. The Hoffmann Reflex: Methodologic Considerations and Applications for Use in Sports Medicine and Athletic Training Research. J Athl Train 2004;39(3):268-277.
12. Hugon M. Proprioceptive reflexes and the H reflex, methodology of the Hoffman reflex in man. In: Desmedt JE, editor. New Developments in Electromyography and Clinical Neurophysiology. Karger: Basel; 1973. p. 277-93.
13. Delwaide PJ. Electrophysiological testing of spastic patients: its potential usefulness and limitations. In: Delwaide PJ, Young RR, editors. Clinical pathophysiology.Amesterdam: Elsevier; 1985. p. 185-203.
14. Joodaki MR, Olyaei GR, Bagheri H. The effects of electrical nerve stimulation of the lower extremity on H-reflex and F-wave parameters. Electromyogr Clin Neurophysiol 2001;41(1):23-8.
15. Rösche J, Rüb K, Niemann-Delius B, Mauch E, Kornhuber HH. Effects of physiotherapy on F-wave-amplitudes in spasticity. Electromyogr Clin Neurophysiol 1996;36(8):509-11.
16. Ghotbi N, Hadian MR, Olyaei GR, Bagheri H, Talebian S, Nakhostin-Ansari N, et al. The investigation of criterion validity of the modified Ashworth scale using the alpha motoneuron excitability indicators. Acta Medica Iranica 2007;45(4):290-4.