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[ORIGINAL ARTICLE]

Comparing the Modified Ashworth Scale and Tardieu Scale with H/M ratio for assessing biceps spasticity in post stroke individuals – A cross-sectional study.

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ABSTRACT

Background: The Modified Ashworth Scale (MAS), the Tardieu Scale, and the H/M ratio are widely regarded as the most dependable methods for evaluating spasticity in stroke patients.

Methodology: A cross-sectional study was conducted on 30 post-stroke individuals aged over 30 years. Spasticity of the biceps muscle was assessed using MAS, Tardieu Scale and H/M ratio.

Results: The analysis of the relationships among the three assessment techniques was conducted using Pearson's correlation coefficient. The results demonstrated a strong positive correlation between MAS and the Tardieu Scale (r = 0.756) and between the Tardieu Scale and the H/M ratio (r = 0.665). A moderate correlation was observed between the H/M ratio and MAS (r = 0.400).

Conclusion: The study's findings indicate that both the MAS and the Tardieu Scale demonstrate a positive correlation with the H/M ratio. The Tardieu Scale shows a more significant correlation.

Keywords: *Hypertonia, Cerebro vascular Accidents, Assessment, H reflex, M wave*

Introduction

One of the most debilitating and degenerative neurological disorders is stroke.[1] It is the second most significant cause of mortality in the world, after coronary artery disease.[2] Stroke risk increases with age, more than tripling after 55 years. Between 1990 and 2016, there was a significant increase in strokes among individuals aged 20-54 worldwide, with a rise from 12.9% to 18.6% of all stroke cases.[3] Stroke deaths are expected to rise from 19% to 36% in India by 2030, based on current figures.[4] Surprisingly, one in every six people may experience a stroke in their lifetime, resulting in biopsychosocial impairments and a significant loss in utility and quality of life.[5]

Early symptoms of a stroke include heaviness or numbness on one side of the body or face, trouble speaking, seeing, walking, dizziness, headache, and lack of coordination.[6] In the early stages of a stroke, individuals may experience hypotonia, difficulty moving one side of the body, and comatose due to neurological shock. This can progress to hypertonia, tightness, contractures, muscle weakness or paralysis, reduced range of motion, movement limitations, and abnormal gait.[4]

Spasticity is a common but unavoidable consequence of stroke. After a stroke, spasticity can cause pain, soft tissue stiffness, and joint stiffness. It can also lead to incorrect limb posture, poor quality of life, greater treatment expenses, and increased carer load. Early detection and treatment of post-stroke spasticity can improve function and independence for those experiencing it.[7]

Spasticity is common in stroke survivors, affecting 30–80% of them. After a stroke, 27% of paretic individuals experience spasticity after one month, 28% after three months, 23% to 43% after six months, and 34% after 18 months. There are no significant studies on the natural progression of spasticity and contracture. Research suggests that after 3 to 6 weeks of a stroke, individuals may have

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persistent loss of joint mobility. Spasticity often develops and peaks 1 to 3 months after a stroke, although the onset varies. While the neurological components of spasticity peak three months after a stroke, the muscle components may grow over time, leading to a higher incidence of spasticity six months later. [7]

Spasticity may be useful and detrimental. Treatment for post-stroke spasticity is not necessary unless it causes significant disability or issues. Spasticity helps maintain mobility, posture, vascular circulation, muscle mass, bone mineral density, and prevent venous thrombosis. Spasticity can impact posture, mobility, comfort, and hygiene. When designing a treatment plan for spasticity, physicians must consider all components of the impairment. Assess if the patient's spasticity helps or hinders function. It's possible that reducing "useful" spasticity might be harmful.[7] For this reason, a thorough spasticity assessment is crucial. Failure to properly assess spasticity may result in the loss of beneficial spasticity that could support the patient's function and better recovery. Therefore, comprehensive evaluation is imperative.

Modern methods of assessing spasticity encompass a range of approaches, which can be broadly classified into two main groups: clinical evaluation techniques and quantitative assessment methods. The evaluation of spasticity in a clinical setting typically begins with a comprehensive review of a patient's medical history and a thorough physical examination. A thorough assessment is conducted during this phase. The subsequent stage involves the physical examination. In this stage, an analysis of the individual's posture is conducted. Muscular tone and tendon reflexes are then evaluated. Muscle tone is evaluated separately for the lower and upper limbs. A comprehensive assessment is performed, encompassing clonus, triple flexion reflex, sole skin reflex, and other abnormal responses, as well as measurements of passive and active joint mobility, voluntary muscle force, contractures, and functional impairment.[8]

A quantitative assessment method for spasticity is crucial for developing treatment plans and evaluating the effectiveness of treatment.[8] Various spasticity measurement tools are present which includes clinical scales such as MAS, Tardieu scale; Electrophysiological methods such as H/M Ratio, F/M ratio and other methods such as Elastography and Myotonometry.[8]

The Ashworth scale (AS) is the best-known and most often utilised. This rating system assesses muscle tone, ranging from 0 (normal) to 4 (severe spasticity). The scale is easy to use, yet the results ultimately rely on the person doing the evaluation. The Modified Ashworth Scale (MAS) was subsequently developed, incorporating further adjustments to the original Ashworth Scale. The scale in question has been widely used due to its ease of use in a clinical environment, as it necessitates no special equipment and poses no risk when administered by the same assessor. The AS and MAS assessments are unable to identify the characteristics that differentiate spasticity from other conditions that affect muscle tone. Adjustments in the evaluator's stretching speed could influence the assessment results because spasticity is influenced by movement rate. These scales are still the most frequently utilised scales.[8]

Another often-used scale is the Tardieu scale, which evaluates spasticity using passive motion. The pace at which passive stretch is achieved is the same, lower, or greater than the speed at which the extremity's parts fall due to gravity. The Modified Tardieu Scale was developed by integrating the assessment positions for the limbs and the degree of spasticity into the original Tardieu Scale.[8]

Non-invasive electrophysiological studies can also be used to evaluate spasticity levels. The Hofmann reflex, or H-reflex, is the most commonly employed electrophysiological method for evaluating spasticity. The H reflex directly gauges the excitability of the alpha motor neuron pool that is directly associated with the spinal column. With increasing stimulation intensity, the amplitude of the H-reflex also rises, and the M-response emerges approximately 3-5 milliseconds after stimulation. The M response is brought about by the activation of all alpha motor neurons located in the spinal cord of the muscle, which is directly stimulated by the muscle efferent nerve. The latency of the H-reflex stays consistent, whereas the amplitude and H/M ratio increase with spasticity.[8]

Despite being readily available, there is limited understanding of the connection between clinical and electrophysiological information in individuals suffering from long-term stroke effects. Their ambiguous interconnections may hinder the development of comprehensive evaluation protocols and the enhancement of treatment strategies. This study aims explore the correlation between spasticity, as assessed using the Modified Ashworth Scale (MAS), Tardieu Scale, and the electrophysiological parameters of H/M ratio in individuals with chronic stroke.

Methodology :

This cross-sectional study was done on 30 stroke individuals. The individuals were conveniently chosen from the Neuro-physiotherapy department of S.S. Agrawal College is located in Navsari. Individual were included based on inclusion and exclusion criteria.

Individuals were included if it follows this criteria: Stroke diagnosed with CT/MRI reports or ascertained by qualified medical professionals, Individuals with positive Babinski sign, Age of individuals with more than 30 years diagnosed with haemorrhagic or ischemic stroke, Brunnstrom stages of recovery stage: 2 to 4, Spasticity of biceps muscle 1,1+, and 2 (According to MAS, Tardieu Scale, H/M ratio), Mini-mental scale examination ≥ 24, Stable medical condition and excluded if individual having Neurological deficits other than stroke, There are no pre-existing limitations of impacted lower limb, Recurrent stroke, Perceptual, visual, or vestibular deficits, Recent surgery to the impacted lower limb.

All individuals were screened using the Modified Ashworth Scale, the Tardieu Scale, and the H/M Ratio. Following screening, all participants were thoroughly informed about the ongoing study and provided written consent to participate, signifying their willingness to do so. Demographic data and baseline characteristics of the individuals were collected using the assessment form.

Spasticity assessment using the Modified Ashworth Scale.

The patient is positioned in a supine lying position. To assess biceps spasticity, place the elbow joint in maximum flexion. Then, the therapist should rapidly and passively move the elbow joint into maximum extension. The patient's spasticity level is then scored according to the grading of the Modified Ashworth Scale. [9]

Spasticity assessment using the Tardieu Scale.

The patient is positioned comfortably in a supine position with the targeted limb supported. The examiner explains the procedure to the patient and ensures they are relaxed. To assess biceps spasticity, the examiner places the elbow joint in a maximally flexed position and then moves the joint into maximal extension at three different speeds over one second. At each velocity, the examiner notes the angle at which muscle resistance is first encountered, known as the "angle of catch." This angle is typically measured using a goniometer. Additionally, the examiner grades the quality of the muscle's response to passive stretch using a 5-point scale, ranging from 0 to 5. [10]

Spasticity assessment using H/M ratio

H-Reflex Procedure (11)

The examiner explains the procedure to the patient and ensures they are relaxed. The examiner checks H-Reflex for flexor carpi radialis (FCR) muscle. The patient is positioned in supine lying with the testing arm relaxed. The active electrode is typically positioned over the midsection of the flexor carpi radialis, specifically at a point that is roughly one-third of the way from the medial epicondyle to the radial styloid. The reference electrode is positioned over the brachioradialis muscle, situated apart from other muscles in the forearm that are innervated by the median nerve. The ground electrode is positioned between the stimulator and the active electrode. Stimulation is given on 2cm above the elbow crease.

Fig.1: Electrode placement for recording H reflex of FCR muscle

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M-Wave Procedure

The examiner explains the procedure to the patient and ensures they are relaxed. The M-wave for the musculocutaneous nerve is then assessed. The patient is positioned in a supine lying position with the testing arm relaxed. For the M-wave assessment of the musculocutaneous nerve, the active electrode is situated one centimetre below the midpoint of the biceps tendon, whereas the reference electrode is positioned over the biceps insertion tendon in the cubital fossa. The ground electrode is located above the belly of the deltoid muscle. Stimulation is applied at the junction between the upper border of the clavicle and the clavicular origin of the sternocleidomastoid muscle.

After taking H-Reflex and M-Wave, H/M Ratio was calculated as follows, [12]

H/M Ratio = H-wave amplitude/M-Wave amplitude

Fig. 2: Electrode placement of Musculocutaneous Nerve for recording M-Wave

Result:

The analysis of mean and standard deviation was conducted as part of the descriptive statistics. The Shapiro-Wilk test was employed to evaluate the normality of the data. For all outcomes, the data conformed to a normal distribution, thus a parametric test was employed. Pearson correlation was employed to correlate all the outcomes with one another. Significance was achieved at a probability of less than 0.05. All statistical analysis was performed using SPSS version 25.

Table no 1: Displays A Summary of Demographic Data Statistics.

Characteristics	Frequency	Percentage (%)
Gender: Male/Female	25/5	83.33/16.66
Dominant Side: Left/Right	4/26	13.33/86.66
Affected side: Left/Right	13/17	43.33/56.66

Table no 2: Displays A Summary of All Variables.

Variables	**Minimum**	**Maximum**	**Mean ± SD**
Age	30.0	76.0	51.14 ± 13.67
Duration since stroke	1.0	192.0	27.60 ± 42.40
Brunnstrom stage of recovery	1.0	7.0	4.28 ± 1.76
MAS	0.00	2.00	0.96 ± 0.57
Tardieu Scale	0.0	2.0	0.89 ± 0.62
H/M Ratio	0.11	1.66	0.88 ± 0.38

Table no 3: Correlation Between MAS and Tardieu Scale

Characteristics	**r value**	**P value (<0.05 sig.)**
MAS and Tardieu	0.756	0.000

Table no 4: Correlation Between Tardieu Scale and H/M Ratio

Characteristics	r value	P value (<0.05 sig.)
Tardieu and H/M Ratio	0.665	0.000

Table no 5: Correlation Between H/M Ratio and MAS

Characteristics	r value	P value (<0.05 sig.)
H/M Ratio and MAS	0.400	0.038

Discussion

This study, which was cross-sectional in nature, involved an assessment of 30 people who had experienced a stroke. The included individuals were undergoing Brunnstrom recovery stages 2 to 4, displayed a positive Babinski sign, and demonstrated biceps spasticity with a severity ranging from grade 1 to 2 on the Modified Ashworth Scale. This study found a statistically significant relationship between the Modified Ashworth Scale and the Tardieu Scale (r = 0.756), in addition to a correlation between the Tardieu Scale and the H/M ratio (r = 0.665). A moderate positive correlation was found between the H/M ratio and the Modified Ashworth Scale (MAS), with a correlation coefficient of r = 0.400. There was also a moderate positive correlation between the duration since stroke and the Tardieu Scale (r = 0.482), as well as between the duration since stroke and the H/M ratio (r = 0.505). Furthermore, a very weak positive correlation was discovered between the duration since stroke and MAS (r = 0.140).

A study undertaken by Chattlani et al. [13] correlated the Modified Modified Ashworth Scale (MMAS) and the Modified Tardieu Scale (MTS) with the H-reflex to evaluate spasticity in the plantar flexors of patients with chronic post-stroke conditions. Their study's findings revealed a positive relationship between the H/M ratio and MMAS (correlation coefficient of 0.812), as well as between the H/M ratio and MTS (correlation coefficient of 0.562), with a p-value of less than 0.05. However, a stronger correlation was found between the H/M ratio and MAS compared to the H/M ratio and MTS. A similar trend was observed in the present study, where a moderate positive correlation was found between the H/M ratio and MAS (r = 0.400), while a strong positive correlation was noted between the H/M ratio and the Tardieu Scale (r = 0.665). The slightly lower correlation between the H/M ratio and MAS in our study compared to Chattlani et al.'s study may be attributed to the fact that they used the Modified Modified Ashworth Scale, whereas we used the Modified Ashworth Scale. Another contributing factor could be environmental variables that we were unable to control in our study setting.

Patel et al.[14] carried out a study called Electrophysiological Evaluation of the Modified Ashworth Scale in the Assessment of Post-Stroke Ankle Plantar Spasticity, which found a substantial positive relationship between the Modified Modified Ashworth Scale (MMAS) and the Modified Tardieu Scale (MTS), with a correlation coefficient of 0.861. The study found a significant negative link between MMAS and the H-reflex, with a correlation coefficient of -0.39. The authors found that MMAS may not be a reliable method for evaluating ankle flexor muscle spasticity in stroke patients. This study discovered a significant positive link between the Modified Ashworth Scale (MAS) and the Tardieu Scale, with a correlation coefficient of 0.756. A moderate positive correlation was found between the H/M ratio and MAS, with a correlation coefficient of 0.400. Our study found similar outcomes, with both the Modified Ashworth Scale (MAS) and the Tardieu Scale exhibiting a positive correlation with the H/M ratio. Patel et al.'s research revealed a negative association between the Modified Modified Ashworth Scale (MMAS) and the H-reflex. Our investigation further showed that both the Modified Ashworth Scale and the Tardieu Scale are effective for assessing spasticity, with the Tardieu Scale indicating greater importance than the Modified Ashworth Scale.

Naghdi et al.[15] conducted a study called Electrophysiological Evaluation of the Modified Tardieu Scale (MTS) in Assessing Post-Stroke Wrist Flexor Spasticity. This study found that there was no notable association between the H/M ratio and the

MTS. The insignificance of the findings was attributed to a small sample size and the failure to test the full range of MTS spasticity grades. The correlation between MTS and the H/M ratio was relatively small, with a Pearson correlation coefficient of 0.25. The findings of this study were characterised by a significant positive correlation between the Tardieu Scale and the H/M ratio, which was found to be approximately 0.665. A study led by Abolhasani A et al.[16] was carried out to compare the reliability of the Modified Modified Ashworth Scale (MMAS) and the Modified Tardieu Scale (MTS) in evaluating wrist flexor spasticity in patients who had suffered a stroke. This study found no significant link between MMAS and MTS. In contrast, this research identified a significant positive association between the Modified Ashworth Scale (MAS) and the Tardieu Scale, with a correlation coefficient of $r = 0.756$, as well as a significant positive association between the Tardieu Scale and the H/M ratio, with a correlation coefficient of $r = 0.665$. A moderate positive correlation was found between the H/M ratio and MAS, which had a coefficient of 0.400.

A comparable study was carried out by A. B. Haung et al.[17] conducted a systematic review of the Tardieu Scale for assessing spasticity. According to their research, the Tardieu Scale provides a more reliable method for evaluating spasticity than both the Modified Ashworth Scale (MAS) and the Modified Modified Ashworth Scale (MMAS). The findings also showed that the Tardieu Scale is more sensitive than other assessment tools. Furthermore, they suggested conducting further investigations to assess the dependability of the Tardieu Scale. In this study, a significant positive relationship was found between the MAS and the Tardieu Scale, with a correlation coefficient of 0.756. The correlation between the Tardieu Scale and the H/M ratio was more significant than the correlation between MAS and the H/M ratio. The results indicate that the Tardieu Scale is more dependable than MAS for assessing muscle spasms.

All the above-mentioned studies on spasticity assessment using various techniques strongly correlate with the present study. Spasticity is a key component of motor learning, and its impairment can compromise goal achievement in individuals with chronic stroke hence assessment of spasticity is mandatory. The conclusion drawn from the previous discussion is that spasticity assessment can be carried out using multiple methods such as the Modified Ashworth Scale (MAS), the Tardieu Scale, and the H/M ratio. However, among these, the Tardieu Scale and the H/M ratio were found to be more reliable as compare to Modified Ashworth scale.

Conclusion :

This study of 30 individuals who have had a stroke found evidence against the null hypothesis, indicating a positive relationship between the Modified Ashworth Scale and the Tardieu Scale and the H/M ratio. The Tardieu Scale showed a more significant correlation, implying it is a more reliable tool for evaluating biceps spasticity in individuals who have suffered a stroke. The Tardieu Scale is more suitable for use as a precise and efficient method for assessing spasticity in clinical settings than the modified Ashworth scale is.

Limitations

1. Environmental factors were unable to be controlled.
2. The type and location of the lesion were not taken into account.

Future Implications

1. Research should concentrate particularly on individuals who have suffered MCA infarct strokes.
2. Spasticity assessment should be extended to other muscle groups also.

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Conflict of Interest

The authors declare no conflicts of interest. The responsibility for the content and writing of the paper lies solely with its authors.

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