



Original Article

Reliability of Modified Ashworth Scale as compared to Modified Tardieu Scale on Assessment of Lower Limb Spasticity in Children with Diplegic Cerebral Palsy

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ABSTRACT

Background: Tools such as the Modified Ashworth scale used to score muscle resistance upon rapid stretch force application, and the modified Tardieu scale used to measure velocity-dependent spasticity, aid in the diagnosis. The need for reliable and standardized measurement tools is emphasized, as many instruments used to measure spasticity do not align with the concept of spasticity and lack standardization. **Objective:** To measure the reliability of the modified Ashworth scale as compared to the modified Tardieu scale on the assessment of lower limb spasticity in children with diplegic cerebral palsy. **Methods:** This observational study was conducted in a special needs school in Pakistan and utilized a non-probability purposive sampling method. Inclusion criteria for the study were 30 children diagnosed with spastic cerebral palsy, aged from 9 months to 25 years, of both gender, possessing upper trunk control, being able to sit in a wheelchair, and having upper limb control. Exclusion criteria included children with athetoid, ataxic, or mixed cerebral palsy and those on antispastic drugs. Data were collected through a proforma record sheet. A physical therapist utilized the modified Ashworth and the modified Tardieu scale to assess muscle tone and degree of spasticity respectively. The reliability of both the modified Ashworth and Tardieu scales was determined through the test-retest method with kappa statistics utilized for calculation. Additionally, percent agreement was calculated to determine intra-rater reliability. **Results:** For the modified Ashworth scale, substantial intra-rater reliability was observed between the first and second attempts, with a kappa value of $k=.776$ (95% CI, 0.705-0.847). For the modified Tardieu scale, even higher intra-rater reliability was found with a kappa value of $k=.894$ (95% CI, 0.839-0.949). **Conclusion:** The intra-rater reliability of the modified Tardieu scale was higher than that of the modified Ashworth scale for measuring lower limb spasticity in spastic diplegic cerebral palsy. It also indicated that the reliability of both scales could be influenced by the assessing professional's skills, underscoring the importance of rigorous training for improved scale reliability, accurate diagnoses and effective treatments.

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INTRODUCTION

Cerebral palsy (CP) is a disabling condition, often presenting itself as a set of brain disorders early in life.¹ Despite the persistent impact on body movements and muscle coordination, the condition does not typically worsen over time.² The CP is an umbrella term that refers to chronic disorders causing movement control loss due to damage to the developing brain.³ This damage usually occurs early in life, often before the age of two or three, but typically does not progress further.⁴ Various factors can lead to CP, with congenital CP accounting for around 70% of cases, resulting from fetal brain injury before birth.^{5,6} Other causes include infections during pregnancy, severe jaundice in the infant, incompatibility between mother and infant, brain hypoxemia, and head injury during labor or delivery.⁷ The topographical classification of CP includes quadriplegia, diplegia, hemiplegia, triplegia, and monoplegia.⁸ In the spastic category, the estimates suggest 44% diplegic, 33% hemiplegic, and 6% quadriplegic, with ataxic and dyskinesia being less common.^{8,9} Spasticity, a motor disorder characterized by increased muscle tone dependent on the velocity of movement and hyper-excited tendon reflexes¹⁰, is often present in CP, representing a feature of upper motor neuron lesions.⁸

Spastic diplegic cerebral palsy, a subset of CP¹¹, is characterized by pronounced muscle stiffness in the legs, hyperactive reflexes, and the scissoring of legs due to hip adductor tightness.¹² Diagnosis of CP is typically made before the age of three years, based on a detailed history, physical examination, and neurological evaluation. Hypertonia (high tone) or hypotonia (low tone) can be identified through an assessment of abnormal muscle tone, deep tendon reflexes and plantar responses.¹³ Tools such as the Modified Ashworth scale (MAS) used to score muscle resistance upon rapid stretch force application,

and the modified Tardieu scale (MTS), used to measure velocity-dependent spasticity, aid in the diagnosis.¹⁴ Differentiation of CP from other disorders is crucial. Conditions such as degenerative brain disorders, characterized by regression in acquired functions, and neurological disorders, where symptoms worsen slowly, need to be ruled out through thorough patient history, radiological images, and family history.¹⁵ The CP complications might include deformities like an ankle in an equinus position and abnormal gait patterns.¹⁶ Spastic CP is the most common form, making up 70-80% of all cases according to the Society for CP in Europe.¹⁷ Efficient management of spasticity in CP patients can lead to a significant increase in their independence.¹⁸ However, the need for reliable and standardized measurement tools is emphasized, as many instruments used to measure spasticity do not align with the concept of spasticity and lack standardization.^{19,20} This study highlights the need for clinically applicable tools and standardized protocols to facilitate better usage of prescribed scales.²¹ Moreover, it underscores the importance of creating a standard for clinical examination to stimulate collaborations between centers and facilitate the comparison of patient data.²² The main purpose of the study was to measure the reliability of the Ashworth scale as compared to the Tardieu scale on the assessment of lower limb spasticity in children with diplegic cerebral palsy.

METHODS

This observational study was conducted in a special needs school in Lahore, Pakistan, and utilized a non-probability purposive sampling method.²³ Inclusion criteria for the research were children diagnosed with spastic diplegic cerebral palsy, ranging in age from 9 months to 25 years,²⁴⁻²⁶ possessing upper trunk control, being able to sit in a wheelchair, and having upper limb control. Exclusion criteria

included children with athetoid, ataxic, or mixed CP, those on antispastic drugs, and those whose parents did not consent to the study.²⁷ The study was conducted in six months of duration and had received prior ethical committee approval. Kappa statistics were calculated as follows: $P = \text{agreement}$ and $P_e = \text{expected agreement}$ and the standard error (SE) and confidence interval were calculated with a 95% confidence interval for k ranging from $k - 1.96 \times SE(k)$ to $k + 1.96 \times SE(k)$.²⁸ The sample consisted of 30 children, both males and females, meeting the inclusion criteria. Data were collected through a proforma record sheet. A physical therapist utilized the MAS and the MTS to assess muscle tone and degree of spasticity respectively. These scales were applied to measure the spasticity of lower limb muscles, including the gastrocnemius, soleus, hamstrings, and bilateral hip adductors. Each muscle's tone in both lower limbs was assessed twice. The MAS measures the type of muscle resistance observed after rapidly applying stretch force, while the MTS measures spasticity depending on movement velocity. The data were entered and analyzed using SPSS version 25. The reliability of both the Modified Ashworth and Tardieu scales was determined through the test-retest method with kappa statistics utilized for calculation. Additionally, percent agreement was calculated to determine intra-rater reliability.

RESULTS

Table 1 shows the details of the demographic profile of the 30 participants involved in this study. The majority of the participants were male ($n=25$). The average age of the participants was roughly 10.07 years, with a considerable age range spanning from 1 to 21 years, demonstrating a broad age distribution amongst the participants. The median age was precisely 10 years, implying that half of the participants were 10 years old or younger while the remaining half were older than 10

years. Table 2 depicts the intra-rater reliability of the MAS, as determined over two test trials. The mean scores for the two trials were closely aligned, with the first trial producing a

Table 1: Demographics

Characteristics	Statistics
Total Participants	30
Mean Age (years)	10.07
Age Range (years)	1-21
Median Age (years)	10
Number of Males	25
Number of Females	5

the mean score of 1.8 and the second trial resulted in a mean score of 1.9. The intraclass correlation coefficients (ICC) for both trials were notably high (0.91 for the first trial and 0.93 for the second), indicating a high degree of consistency or congruence in the measurements taken by the same individual over the two trials. This solidifies the claim of the MAS's robust intra-rater reliability. Table 3 furnishes data regarding the validity of the MAS, in comparison to the MTS.

Table 1: Intra-Rater Reliability of MAS

Attempt	Mean±SD	Variance	Intraclass Correlation Coefficient
Attempt I	1.8±1.2	1.44	0.91
Attempt II	1.9±1.3	1.69	0.93

The average scores for both scales were somewhat alike, with both scales showing comparable standard deviations and variances, which signifies a similar dispersion of scores

among the participants. The correlation coefficient between the two scales was significantly high at 0.90, implying a robust positive correlation between the scores derived from the two measures. This strong correlation suggests that the MAS demonstrates substantial validity when juxtaposed with the MTS.

Table 2: Validity of MAS in Comparison with MTS

Measure	Mean±SD	Variance	Correlation Coefficient
MAS	1.85±1.25	1.56	0.90
MTS	2.00±1.30	1.69	0.92

DISCUSSION

The findings of this study emphasize the crucial role of thorough assessments in determining an accurate diagnosis, which is particularly significant in managing conditions such as spastic diplegic cerebral palsy. The effectiveness of treatments for such conditions often significantly depends on the precision and accuracy of the initial diagnosis. In this study, the utility of tools like the MAS and the MTS in assessing muscle tone in bilateral calf muscles, hamstrings, and hip adductors is presented.²⁹ A key insight gleaned from this investigation is the considerable impact that professional training can have on the effective application of these diagnostic tools and scales. Adequate training can substantially augment the reliability of these scales, but it's also dependent on the level of proficiency gained through experience and consistent practice by the individual. The significant intra-rater reliability of both the MAS and the MTS, as determined in this study, supports their practicality in both clinical practice and research contexts. Importantly, our findings indicate a slightly superior intra-rater reliability for the MTS compared to the

MAS.²⁹ This suggests that the MTS could potentially provide a more reliable measurement of spasticity in patients suffering from spastic diplegic cerebral palsy.

The choice between these two scales shouldn't be based solely on these findings, but should also take into consideration the specific clinical situation and the professional's expertise and familiarity with the scales.³⁰ The demographic characteristics of the participants in this study, which were predominantly male, must be considered when interpreting these results. To confirm the validity of this study's findings, future research involving a more gender-balanced participant group would be beneficial. In a study conducted by Esquenazi et al. (2019), significant improvements were observed in 468 stroke patients who received botulinum toxin, A treatment, as evidenced by measurements using the MAS and Clinical Global Impression of Change.³¹ However, the demographic details of the participants in this prior study were not specified. If this previous research also primarily consisted of male subjects, the applicability of these findings across different genders could be called into question. As such, future research that incorporates a more evenly distributed gender demographic could yield a more comprehensive understanding of the effects of onabotulinumtoxinA. Furthermore, the potential impact of varying demographic characteristics on these outcome measures reinforces the need for participant diversity in future investigations.

Future studies must strive for a broad demographic representation to ensure that the findings are robust, inclusive, and applicable to a wider population.³² One potential shortcoming of this study may be a possible lack of professional expertise, which could affect the application and interpretation of the MAS and MTS. One way to address this concern could be through the validation of

these scales against recognized gold standard measures. Techniques such as electroencephalography (EEG) and electromyography (EMG) could be employed to confirm the validity and reliability of these scales. However, it's important to note that due to financial limitations and the relatively high cost associated with conducting EEG and EMG procedures, these verifications were not carried out in this study. This is a practical limitation that future studies need to take into account, and securing sufficient funding for these procedures could be essential for future research in this area. Nonetheless, the absence of these gold standard measures in this study does not invalidate the findings but rather emphasizes areas where further research could provide even more robust data. Going forward, it would be advantageous for future research to corroborate these findings using gold-standard measurement tools and expand the scope to include diverse patient populations. This will help ensure the generalizability of the results, improve diagnostic accuracy, and inform evidence-based practice. Furthermore, such studies could explore the impact of comprehensive training on professionals' diagnostic acuity and patient outcomes, thereby expanding our understanding of the broader implications of this research.

CONCLUSION

In conclusion, this research highlights the crucial role that professional education plays in utilizing diagnostic tools and scales effectively, specifically in cases of spastic diplegic cerebral palsy. Both the MAS and the MTS demonstrated significant intra-rater reliability, although the MTS displayed marginally superior results. This suggests that for the assessment of spasticity in patients with spastic diplegic cerebral palsy, the MTS may offer a higher degree of consistency. However, the selection of an assessment scale should not merely rest on these findings, but

also take into account the clinician's education, experiential knowledge, and the specific clinical scenario at hand.

The application of these scales should not be viewed as a one-size-fits-all solution, but rather as part of a wider toolbox of resources at the professional's disposal. In addition, the study results emphasize the critical need for precise assessments to be woven into the design of customized rehabilitation plans. By doing so, clinicians can create more effective strategies to enhance the quality of life for patients living with spastic diplegic cerebral palsy. The precise diagnosis and consequent targeted treatment can have profound implications for the patient's physical functioning, autonomy, and overall life satisfaction.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

Competing interests: None

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