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Quantitative Measurement of Muscle Spasticity for Neurological Disorders Using Mechanomyography: A Statistical Analysis

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Abstract

Spasticity, a common sign of upper motor neuron syndrome, affects conditions such as stroke, cerebral palsy, traumatic brain injury, and spinal cord injury. The Modified Ashworth Scale (MAS) is widely used by therapists to evaluate spasticity during passive flexion to the appropriate joints of limbs according to the level of muscle resistance, but its reliance on subjective judgment can lead to inconsistent assessments and impact rehabilitation strategies. This study introduces Mechanomyography (MMG) as a quantitative approach for assessing spasticity in the forearm muscles of 30 patients (29 stroke, 1 cerebral palsy), with ethical approval and informed consent. Before feature extraction, the data underwent thorough pre-processing, yielding a dataset of 48 features derived from the x, y, and z axes in three dimensions, representing the longitudinal, lateral, and transverse orientations of biceps and triceps muscle fibers. The extracted features were

subjected to statistical analyses, including linear regression, Pearson correlation, and one-way MANOVA, to examine the relationship between MMG signal features with muscle spasticity levels as quantified through the MAS. Linear regression showed a significant positive association ($R = 0.881$, $F(41,48) = 4.076$, $p < 0.001$), with MMG features contributing 77.7% of MAS variability ($R^2 = 0.777$). Pearson correlation revealed strong associations, with $Miny_1$ negatively correlated ($r = -0.542$) and $RMSy_1$ positively correlated ($r = 0.515$). Additionally, one-way MANOVA confirmed significant differences in MMG features across MAS levels, validating their relevance in spasticity assessment. These results establish MMG as a reliable, objective tool for spasticity evaluation, advancing beyond traditional subjective methods. © 2025, National University of Malaysia. All rights reserved.

Author keywords

Linear Regression; MANOVA; Mechanomyography; Modified Ashworth Scale; Pearson Correlation; Spasticity

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