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

By Daud, MAI (Daud, Muhamad Aliff Imran) [1] ; Puzi, AA (Puzi, Asmarani Ahmad) [1] ; Sidek, SN (Sidek, Shahrul Na'im) [2] ; Ghazali, AS (Ghazali, Aimi Shazwani) [2] ; Zainuddin, AA (Zainuddin, Ahmad Anwar) [1] ; Khairuddin, IM (Khairuddin, Ismail Mohd) [3] ; Mutalib, MAA (Mutalib, Mohd Azri Abd) [4]

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Source JURNAL KEJURUTERAAN

View Journal Impact

Volume: 37 Issue: 6 Page: 2589-2601

DOI: 10.17576/jkukm-2025-37(6)-02

Published NOV 2025

Indexed 2025-10-13

Document Type Article

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 ($R\text{-}2 = 0.777$). Pearson correlation revealed strong associations, with Miny1 negatively correlated ($r = -0.542$) and RMSy1 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

Keywords **Author Keywords:** Spasticity; Mechanomyography; Modified Ashworth Scale; Linear Regression; Pearson Correlation; MANOVA

Author Information

Corresponding Address: Puzi, Asmarani Ahmad (corresponding author)

Int Islamic Univ Malaysia, Dept Comp Sci, Kuala Lumpur, Malaysia

E-mail Addresses :

asmarani@iium.edu.my
Addresses :
[1] Int Islamic Univ Malaysia, Dept Comp Sci, Kuala Lumpur, Malaysia
[2] Int Islamic Univ Malaysia, Dept Mechatron Engn, Kuala Lumpur, Malaysia
[3] Univ Malaysia Pahang Al Sultan Abdullah, Fac Mfg Engn, Pekan, Malaysia
[4] SIRIM Berhad, Dept Machine Design, Hulu Selangor, Malaysia
E-mail Addresses :
asmarani@iium.edu.my

Categories/ Classification

Research Areas: Engineering

Citation Topics: 1 Clinical & Life Sciences › 1.82 Gait & Posture › 1.82.1066 Cerebral Palsy

Sustainable Development Goals: 03 Good Health and Well-being

Web of Science Categories

Engineering, Multidisciplinary

Funding

View funding text

Funding agency	Grant number
Biomechatronics Research Laboratory within the Kulliyyah of Engineering at the International Islamic University Malaysia	
Ministry of Education (MOE) under the Fundamental Research Grant Scheme	FRGS/1/2022/TK07/UIAM/02/6

+ See more data fields

Journal information