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Potential Parameters for Wrist Accelerometer and Gyrosensor in Functional Evaluation of Stroke

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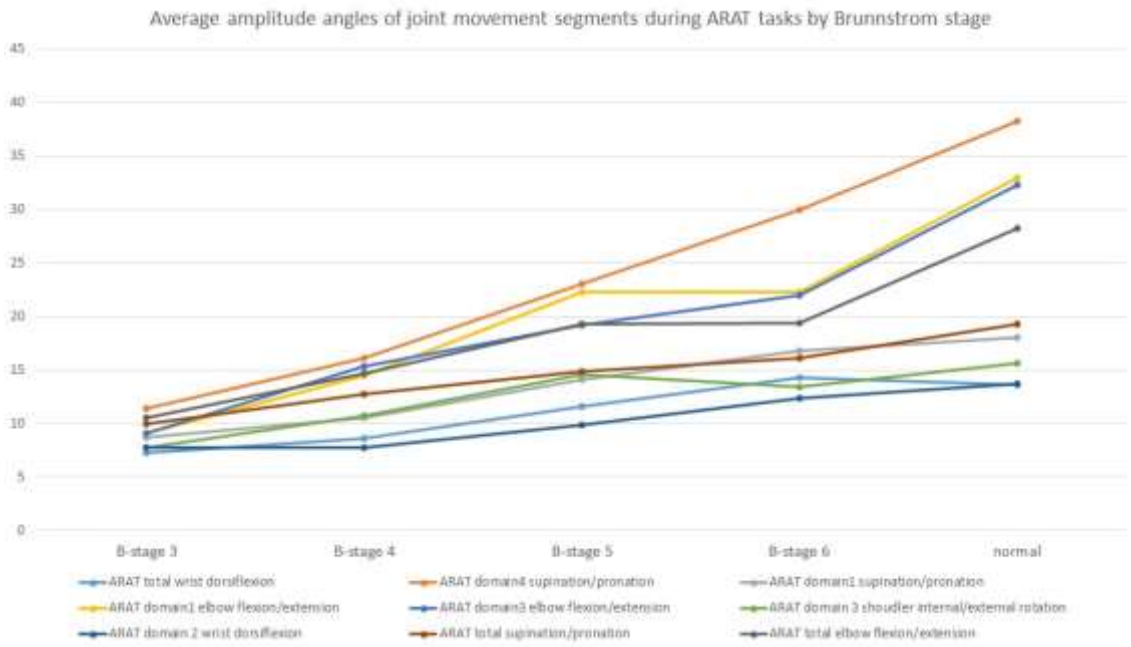
Despite many studies on accelerometers and gyrosensors were performed regarding movements of upper extremity in stroke, yet there exist no standardized evaluating methods especially in terms of significant clinical relevance. In this study, we aimed to determine potential parameters and appropriate tasks that may serve as clinical outcome measures or an index, which can be measured with a single sensor on the wrist. Ten healthy volunteers and nine patients with hemiplegic stroke were recruited to perform Action Research Arm Test (ARAT) and a series of tasks representing activities of daily living (ADL). They were equipped with multiple IMU sensor based upper body motion capture system during the tasks. Acceleration values of the wrist and hand sensors in three global orthogonal directions and Euler angles of sensors in each segment of the upper limb with reference to their proximal segment sensors were measured. ARAT score and Brunnstrom stage were evaluated for all patients. Average amplitude and maximum amplitude of the movement segments, logsum and logsum per time was extracted and analyzed. Logsum was defined as integration of all displacements or changes for corresponding measurements. Of the parameters that showed significant differences in values between healthy subjects and patients and also significant correlation with clinical measures, average amplitude of forearm supination/pronation angle during ARAT domain 4 tasks demonstrated significant decline of the value in severely impaired patients compared to normal subjects (29.83%) and profound difference between severely and mildly impaired patients (48.46%). During ADL tasks, logsum per time for supination/pronation showed significant difference between severity levels (38.33%). Average amplitude of acceleration in x-axis (left-right) and z-axis (up-down) of hand and wrist sensors during ARAT tasks demonstrated a range of 45 to 62% value compared to healthy subjects, with 21.6 to 35.1% difference along the severity spectrum. Although accurate measurement of upper extremity movements with single wrist sensor may not be possible, specific parameters which are available from a wrist-worn sensor may play a significant role in simple or serial functional evaluation as an important predictor of clinical outcome measures.



Average amplitude angles of joint movement segments during Action Research Arm Test tasks are shown by Brunnstrom stages