Clinical and kinematic assessments of upper limb function in persons with post-stroke symptoms

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Stroke is a common and multifaceted disease that often involves motor deficits in the upper limb. This thesis investigated reliability and validity of existing clinical assessments of upper limb function in persons with post-stroke symptoms and in non-disabled controls. Study I was conducted in a clinical setting where the Motor Evaluation Scale of Upper Extremity in Stroke patients (MESUPES) was assessed in persons post-stroke by two physiotherapists selected from a group of four. Study II-IV took place in a motion analysis laboratory with an optoelectronic system. Kinematic measures and clinical measures were used to investigate the validity of the Arm Posture Score (APS), the Finger-to-Nose test (FNT), and the Standardised Nine Hole Peg test (S-NHPT) in persons post-stroke and non-disabled controls.

The results showed that the MESUPES had a high inter-rater reliability while the concurrent validity was not fully confirmed. MESUPES has a maximum score of 58 and the minimal detectable change ranged from 5 to 8 for a confidence level of 80% and 95%. The Arm Posture Scores, which include either four or six arm movement variables, were able to distinguish between the affected and non-affected arms, as well as between the affected arm and the non-dominant arm of the controls. The total movement time of the FNT, which is a coordination test, was able to distinguish persons post-stroke from controls, at least at a group level. Movement smoothness, accuracy and compensation, obtained from kinematic analysis, were the most discriminative variables for the FNT. Smoothness was most strongly correlated with the timed FNT and had the greatest association with the variance of the timed FNT. For the S-NHPT, which is a dexterity test involving grasping and reaching, the movement times, smoothness and compensation discriminated between the stroke group and the control group. Persons post-stroke spent considerably more time in the grasp-related parts of the task compared to controls. Smoothness and upper limb impairments had the strongest correlation with the S-NHPT.

In conclusion, the clinical measures used within stroke rehabilitation seem valid and reliable, although some limitations are highlighted by the kinematic assessment. MESUPES was shown to be a reliable assessment of upper limb movement quality after stroke. The kinematic analysis revealed that the timed FNT does not have sufficient discriminative validity at an individual level. The timed FNT reflected speed-related aspects of pointing movements such as smoothness and length of the deceleration phase, but should not be used as an overall measure of upper limb coordination after stroke. The timed S-NHPT demonstrated sufficient discriminative validity and reflected smoothness and upper limb impairments. For both the FNT and S-NHPT, kinematic analysis showed that the clinical outcomes of those tests (time of performance) did not adequately detect qualitative aspects of the upper limb movements after stroke such as possible compensatory movements. Therefore, clinical assessments that capture qualitative aspects of upper limb movements would improve the assessment of upper limb coordination and dexterity after stroke. In addition, 3D movement analysis provided unique information about upper limb function after stroke, not least in persons with mild post-stroke impairments. The APS, for instance, which quantifies how much the arm swing during gait deviates from normal, discriminated between persons with stroke and non-disabled persons. Such subtle deviations are not possible to quantify with the human eye.

Keywords
Cross-sectional studies, arm, hand, gait, outcome assessment, clinical laboratory techniques