Objective Assessment of Upper Extremity Function in Neurorehabilitation

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PROJECT DESCRIPTION:

An objective assessment system for stroke upper extremity (UE) rehabilitation is long overdue.

Currently,

1) Clinical assessment of UE function often lack sensitivity, objectivity, or attention to the quality of movement.
   2) Instrumented assessments are often time-consuming to perform and require skill to interpret.

Kinematic assessment:
With advancements in human motion capture technology and UE biomechanical modelling, kinematic analysis of UE functional tasks is fast becoming a viable option that supplements current clinical assessment practises. Importantly, kinematic analysis has been shown to be reliable, objective and sensitive. Furthermore, it does not suffer from floor and ceiling effects.

Reach-to-grasp is one of the most common UE therapeutic and assessment functional activities used in both clinical and research settings. It consists of three inter-dependent movement components, (i) orientation, (ii) transport and (iii) grasp. It is proposed that a finite number of motor strategies exist to coordinate these components. The hand transport tangential velocity (TVel) profile is widely used to characterize the performance of a reach-to-grasp task and is sensitive to deviation from normal movement. In addition, TVel during reaching has previously been shown to be a sensitive marker of upper limb motor recovery. Hence, this study aims to contribute towards the development of an objective assessment system for stroke UE rehabilitation by using the hand transport TVel profile of 2 reach-to-grasp tasks.

In this study, a criterion-referenced approach is used. For the purpose of establishing a ‘normal’ criterion for the reach-to-grasp tasks, normative hand transport TVel profiles are obtained from a sample of healthy subjects using a repeated measure experimental design. In order to construct accurate normative hand transport TVel profiles, intra and inter subject TVel temporal variances need to be minimised so as to reduce erroneous TVel amplitude variances. A novel nonlinear time normalisation procedure is proposed to reduce intra-subject TVel temporal variance. This procedure is based on the landmark curve registration technique. Important kinematic landmarks are identified via detailed comparisons of hand transport TVel profiles between different experimental conditions. Inter-subject temporal variance is reduced by means of identifying clusters (groups) of identical hand transport TVel profiles using the k-means algorithm. As a result, it is determined that multiple groups of normal hand transport TVel profile exist for the 2 reach-to-grasp tasks in this study.

A pilot trial involving hemiplegic stroke patients is conducted. A novel objective assessment method based on the normative hand transport TVel profiles is proposed. This method quantifies a patient’s reach-to-grasp performance by comparing his hand transport TVel profile amplitude and temporal
correlation with the normative hand transport TVel profiles. It is clearly demonstrated that the proposed method is capable of detecting pathological reach-to-grasp movements.

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**PUBLICATIONS:**

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*Refereed Conference (Published/In Press):* Nil.

*Book Chapter:* Nil.