Development and validation of upper extremity kinematic movement analysis for people with stroke

Reaching and drinking from a glass

Akademisk avhandling

som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin vid
Göteborgs universitet kommer att offentligen försvaras i
hörsal Arvid Carlsson, Academicum, Medicinaregatan 3,

fredagen den 6 december 2013, kl 09.30

av

Margit Alt Murphy
Legitimerad sjukgymnast

Fakultetsopponent:
Professor Charlotte Häger
Institutionen för samhällsmedicin och rehabilitering
Umeå Universitet

This thesis is based on the following studies:

I. Alt Murphy M, Sunnerhagen KS, Johnels B, Willén C. Three-dimensional kinematic motion analysis of a daily activity drinking from a glass: a pilot study. *Journal of Neuroengineering and Rehabilitation 2006; 3:18.*

II. Alt Murphy M, Willén C, Sunnerhagen KS. Kinematic variables quantifying upper-extremity performance after stroke during reaching and drinking from a glass. *Neurorehabilitation and Neural Repair 2011; 25(1):71-80.*

III. Alt Murphy M, Willén C, Sunnerhagen KS. Movement kinematics during a drinking task are associated with the activity capacity level after stroke. *Neurorehabilitation and Neural Repair 2012; 26(9):1106-1115.*

IV. Alt Murphy M, Willén C, Sunnerhagen KS. Responsiveness of upper extremity kinematic measures and clinical improvement during the first three months after stroke. *Neurorehabilitation and Neural Repair 2013; 27(9): 844-853.*

UNIVERSITY OF GOTHENBURG

Development and validation of upper extremity kinematic movement analysis for people with stroke

Reaching and drinking from a glass

Margit Alt Murphy
Institute of Neuroscience and Physiology, Department of Clinical Neuroscience and Rehabilitation,
The Sahlgrenska Academy at the University of Gothenburg Göteborg, Sweden

ABSTRACT

Kinematic analysis is a powerful method for objective assessment of movement performance, and is increasingly employed as outcome measure after stroke. The number of studies investigating natural, goal-oriented daily tasks is however small. Likewise, little is known how the actual movement performance measured with kinematics is related to the traditional clinical assessment scales. Furthermore, only few studies investigated longitudinal changes and evaluated what these changes mean in context of an individual's functioning after stroke.

The overall aim of this thesis was to develop a method of three-dimensional movement analysis for a purposeful upper extremity task "drinking from a glass" and to evaluate the cross-sectional and longitudinal validity of the kinematic measures in relation to impairments and activity limitations in people with motor deficits after stroke.

Methods: The studies reported in the current thesis included 29 healthy individuals and 82 individuals with stroke. A standardized test protocol for the drinking task was developed and its consistency was examined. A five camera optoelectronic motion capture system with passive markers was used to measure both temporal and spatial kinematic characteristics of movement performance. The clinical outcomes used in the different studies were: Fugl-Meyer Assessment for Upper Extremity, Action Research Arm Test and ABILHAND. The construct and criterion validity was examined in subacute and chronic stages after stroke; the longitudinal change and responsiveness was evaluated during the first three months after stroke.

Results: The test protocol of the drinking task demonstrated a good consistency in test-retest. The explorative analysis of kinematic data revealed that the drinking task can be described with two major factors in people with stroke. One of them included predominantly measures of temporal nature and the other comprised primarily spatial movement pattern measures. Four kinematic measures: movement time, movement smoothness, angular velocity of the elbow and compensatory trunk displacement; demonstrated to be most effective in discriminating among individuals with moderate or mild impairment level after stroke and healthy persons. Three kinematic measures: movement smoothness, movement time and trunk displacement demonstrated strongest association with upper extremity activity capacity level after stroke. All those three kinematic measures showed to be responsive for capturing improvements in upper extremity activity during the first three months after stroke.

Conclusions and clinical implications: Three kinematic measures of the drinking task: movement smoothness, movement time and trunk displacement; demonstrated to be valid and responsive measures for characterizing the upper extremity function and to capture an improvement over time after stroke. It can be concluded, that the test protocol of the drinking task as described in this thesis is feasible for clinical studies and provides objective, valid and clinically interpretable data of an individual's actual movement performance during the drinking task. This knowledge facilitates both clinical and movement analysis research and can be valuable in the area of bioengineering when assessment methods for new technology based devices are developed.

Keywords: kinematics, upper extremity, arm, task performance and analysis, Activities of Daily Living, outcome assessment, motion analysis, stroke

ISBN: 978-91-628-8807-7 http://hdl.handle.net/2077/33117