



**Karolinska
Institutet**

Institutionen för Kvinnors och Barns Hälsa

Development and evaluation of a new method to objectively measure spasticity

AKADEMISK AVHANDLING

som för avläggande av medicine doktorsexamen vid Karolinska Institutet offentligen försvaras i Skandiasalen, Astrid Lindgrens Barnsjukhus.

Fredagen den 8 november 2013 kl. 09.00

av

Johan Gäverth

Leg. Sjukgymnast, MSc

Huvudhandledare:

Professor Hans Forssberg
Karolinska Institutet
Institutionen för Kvinnors och Barns Hälsa
Enheten för Neuropediatrik

Bihandledare:

Professor Ann-Christin Eliasson
Karolinska Institutet
Institutionen för Kvinnors och Barns Hälsa
Enheten för Neuropediatrik

Påvel Lindberg, PhD

Karolinska Institutet
Institutionen för Kliniska Vetenskaper,
Danderyds Sjukhus
och
CNRS UMR 8194
Université Paris Descartes, Paris, Frankrike

Fakultetsopponent:

Diane Damiano, PhD
National Institutes of Health
Clinical Center, Bethesda, MD, USA

Betygsnämnd:

Professor Karin Harms-Ringdahl
Karolinska Institutet
Institutionen för Neurobiologi, Vårdvetenskap
och Samhälle
Sektionen för Sjukgymnastik

Professor Lars Larsson
Uppsala Universitet
Institutionen för Neurovetenskap,
Klinisk Neurofysiologi

Docent Dag Nyholm
Uppsala Universitet
Institutionen för Neurovetenskap,
Neurologi

Stockholm 2013

ABSTRACT

Spasticity is a neurological symptom that can occur after stroke and traumatic brain injury due to a lesion of the motor pathways descending from the brain to the brainstem and spinal cord. Spasticity is characterised by a velocity-dependent increase in resistance when muscles are passively stretched. There is a lack of valid measures of spasticity, which creates difficulties both in following the development of symptoms and in evaluation of potential treatment interventions.

The overall aim of this thesis was to develop and evaluate a new objective measure able to separately quantify spasticity and other components of passive muscle resistance in the wrist and finger flexor muscles. A biomechanical model was developed and adopted into a measurement instrument that performs passive isokinetic movements extending the wrist and finger flexor muscles. The model estimates three different components of the measured resistance to passive movement: neural (spasticity, NC) and non-neural (elastic, EC and viscous, VC) components.

The aim of Study I was to evaluate the new measurement model and to examine its validity. The model was adopted into a measurement instrument, the NeuroFlexor. The aim of Study II was to investigate the reliability and measurement error of the method. The aim of Study III was to investigate the method's sensitivity to change, which was examined in the context of treatment with botulinum toxin type A. In Study IV, the NeuroFlexor was used to explore the relationship between spasticity and other measures of upper limb body functions and activity. In all four studies, the participants were all adults in the chronic stage after stroke or traumatic brain injury.

The results from Study I showed that there was a strong association between the NC (spasticity) and the stretch reflex measured with surface electromyography (EMG). This was clearly shown in a nerve block test. The results also showed that the NC but not the EC and VC increased with increasing velocity of the muscle stretch. These results are in accordance with the definition of spasticity, and therefore constitute evidence of the method's validity. The results from Study II showed a high reliability of the NeuroFlexor method both within and between raters. In Study III sensitivity to change was demonstrated. The results from this study showed that the method is sensitive enough to detect change on a group level; however, its sensitivity to change on the individual level needs to be explored further. In Study IV, the results showed that spasticity had only weak to moderate associations with other measures of function and activity.

The overall clinical implications and conclusions from this thesis are that this new method to measure spasticity is valid and is able to distinguish between spasticity and other components of passive muscle resistance in the wrist and finger muscles. The new method shows good psychometric properties making it a suitable alternative for more accurate clinical measurement of spasticity.