XVII International Symposium on Computer Simulation in Biomechanics
July 28th – 30th 2019, Alberta, Canada

Correlation between Modified Ashworth Scale and model components of passive stiffness of spastic wrist joint in chronic stroke survivors

Le Li[1,*], Ruihao Bian[1], Xin Huang[1] , Zichong Luo[2]

[1] The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China
[2] Faculty of Science and Technology, University of Macau, Macau, China;
Email: lile5@mail.sysu.edu.cn

INTRODUCTION

Spasticity, a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks[1], is a common motor dysfunction which causes difficulties to motor recovery to patients in many neurological diseases, such as stroke. The understanding of the contributions from elasticity and viscosity caused by alterations of muscle and tissue properties to spasticity is still limited [2]. In clinic, Modified Ashworth Scale (MAS) is used to measure spasticity, and it has been questioned before due to its unsatisfactory reliability [3]. Therefore, more objective, valid and reliable clinical methods are still limited to identify and quantify spasticity and to guide intervention[4]. Biomechanical models and simulation have been used to quantify spasticity [5]. In this study, we investigated components of passive movement resistance of the wrist flexor after stroke in chronic stage by using a biomechanical model combined motorized mechanical device, and explored the correlation between these components and MAS.

METHODS

A cross-sectional study was performed in 19 stroke survivors who were admitted to the First Affiliated Hospital, Sun Yat-sen University (Table 1). The study was approved by the Ethics Committee of the hospital and was conducted in accordance to the Declaration of Helsinki. All subjects provided written informed consent prior to enrollment. Passive resistance torque of wrist joint of both sides of the subjects were measured by a motorized mechanical device (NeuroFlexor, Aggro MedTech AB, Solna, Sweden) [6](Fig 1). Subjects were asked to keep resting and instructed to not take any active movements during measurements. The instrument runs at 5°/s and 236°/s with and without hand load. Range of the wrist movement was from 20° flexion to 30° extension. The passive resistant force and the joint angle were recorded simultaneously. There are three components are obtained based on the measurement results and a biomechanical model[6]: Neural Component (NC) which represents spasticity, Elasticity Component (EC) and Viscosity Component (VC), the alterations in muscle and tissue properties. In this model, the EC and VC are mainly from data collected during the passive stretch movement at 5°/s while the NC is calculated during the passive stretch at 236°/s with the EC and VC removed. The reflexes or the muscles and tissue changes is clear in this model.

Modified Ashworth Scale was assessed with score of 1+ in MAS was taken as 1.5 in the statistical analysis. Comparison of the components between paretic side and non-paretic side was calculated using t-test. Spearman's rank correlation was used to explore relation between MAS and the components. The significance level was set at $p<0.05$.

Fig 1: the NeuroFlexor device and alignment of the limb

RESULTS AND DISCUSSION

As shown in Fig.2a, NC of the paretic side (mean± SD, 4.69±2.84N) was significantly higher than the non-paretic side (2.08±1.59N, p=0.000). NC in the paretic side had significant correlation with MAS (r=0.899, p=0.000).

The results showed that NC was higher in the paretic side of stroke survivors than non-paretic side (Fig.2b). NeuroFlexor has been applied to evaluate contributions to the hyper resistance during the passive stretching in other neurological conditions [7]. These findings combined our results showed that it is a feasible method to document spastic muscle with stiffness. Furthermore, only NC showed significant correlation with MAS, which was in line with the definition of spasticity. Many researchers considered the reliability of MAS was poor to moderate and is set subjectively by the examiner which is likely to be influenced by the placebo effect [2]. Therefore, it is better to combine quantitative evaluation to provide objective information of spasticity.

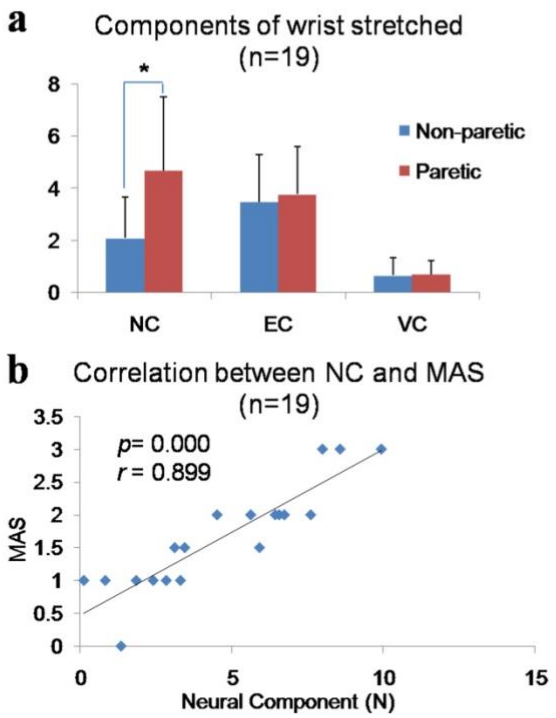

Fig 2: a. components of wrist stretched (n=19) , *p<0.05; b: correlation between NC and MAS (n=19)

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ACKNOWLEDGEMENTS

This study is in part supported by ISB EDC project.