EFFECTS OF INITIAL MUSCLE LENGTH IN STRETCH REFLEX EXCITABILITY IN PEOPLE WITH POST-STROKE SPASTICITY AND HEALTHY VOLUNTEERS

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INTRODUCTION

Stretch reflex excitability is influenced by neural (e.g. feed-forward and feedback mechanisms) and biomechanical components (e.g. muscle length). Spasticity is a motor disorder resulting from hyper-excitability of the stretch reflex [Lance JW, 1980]. Measurements of spasticity predominantly focus on the velocity dependent property of the stretch reflex.

There are divided opinions whether the initial muscle length affects the stretch reflex properties [Yamamoto, 2000; Lin, 1999]. The objective of this work was to quantify the stretch reflex parameters of the biceps brachii at two different initial muscle lengths in non-impaired (NI) volunteers and stroke patients (SP) with elbow spasticity and objectively evaluate their differences.

METHODS

A biomechanical device capable of eliciting a stretch reflex during a 50 ms controlled stretch perturbation to the elbow joint was designed. Stretch reflex response was measured at 75° and 105° flexion (full extension was 0°). Surface EMG electrodes were placed on the biceps brachii. The torque applied at the elbow was determined by presetting the tension of a spring, in this case of 13.68 Nm, which is the second maximum tension of the operational range in the device. A footswitch released the tension instantaneously stretching the biceps brachii. A potentiometer recorded the changes in angle. All signals were sampled at 4096 Hz.

Data analysis was set to commence 150 ms before (background activity) and to complete 450 ms after the footswitch was activated. EMG signals were full wave rectified and filtered at 15 Hz. The outcome measurements for this study were the reflex amplitude, latency, rise time and duration (figure 1). A one-way ANOVA was used to test for significant differences.

RESULTS AND DISCUSSION

Seventeen NI volunteers (mean age 35; range 24-55 years) and 14 SP with spasticity (mean age 67; range 52-86 years) resulting from a CVA six months previously were included.

The stretch reflex was elicited in all NI volunteers in the lengthened position (75° flexion) but only in 12 in the shortened position (105° flexion). It was elicited in all of the SP volunteers regardless of the muscle length.

In the NI population the reflex amplitude and the latency at the shortened position was significantly lower than that of the lengthened position (p<0.05). The duration of the reflex slightly increased at the shortened position (p=0.087). No significant differences were found in the rise time (p>0.05).
In the SP population, the primary variables that were used to characterize the stretch reflex, i.e. the amplitude, latency, duration and rise time, did not significantly change with changes in muscle length (p<0.05).

Comparisons between the NI and SP populations, in the shortened position, showed no significant differences in the reflex amplitude, latency, duration and rise time (p>0.10). However, for the lengthened position the reflex amplitude and latencies were significantly smaller (p<0.05). No other significant differences were found in the rest of the variables.

Length dependent changes in the reflex amplitude are consistent with the literature [Yamamoto, 2000; Nordin, 1996]. This suggests increased passive stiffness of the muscle reduces the required EMG activity to maintain the elastic properties of the muscle. [Lin, 1998].

Reduced latencies in NI at shorter lengths may suggest an increased sensitivity of the muscle spindles. The reasons for these differences are being explored.

The lack of differences in all reflex parameters in the SP population and the results between the groups suggest that there are indeed changes in the stretch reflex excitability after stroke but that muscle length may not have an influence it. This could be due to soft tissue changes that sometimes accompany spasticity.

**SUMMARY**

The characterization of the stretch reflex under different conditions is necessary to understand the neurophysiology and changes occurring after neural injury. This work was intended to clarify the influence of initial muscle length. Changes in the reflex properties due to different initial muscle lengths were more evident in the NI population, suggesting that the modulation of the reflex is lost with after stroke and remains at the same level regardless the muscle length. However biomechanical changes of the muscle may also have influence such modulation. Further work is being performed to observe other factors affecting the stretch reflex excitability and how to dissociate neural from non-neural components.

**REFERENCES**


