Presentation Abstract

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Presentation Title: Muscle contributions to ballistic reaching kinematics in individuals with chronic stroke

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Topic: ++D.17.g. Stroke, damage, or disease: Mechanisms of abnormal movement

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Abstract: Motor impairments such as abnormal muscle co-activation (flexion synergy) and hyperactive stretch reflexes (spasticity) are thought to greatly disrupt reaching function following stroke. In this investigation, the individual contributions of both are considered and the hypothesis tested is whether abnormal flexor co-activation is the dominant contributor to impaired reaching. In this study, participants made ballistic horizontal reaches on the admittance-controlled robot, the ACT³D. Reaches were performed while elevating the arm just above a horizontal haptic surface/plane at five different abduction loads standardized to increasing percentages of the participant’s maximum abduction strength. As a general effect, peak elbow angular velocity decreased significantly (p<0.05) as a function of abduction loading as one would expect should flexion synergy and/or spasticity be at play. We compared elbow muscle activation during time-windows anchored to the onset of ballistic reaching. EMG analysis indicated that at the onset of lifting the arm and maintaining a quasi-static starting position, elbow flexor activation increased (p<0.05) as a function of abduction loading illustrating the manifestation of flexion synergy. This flexor activity was countered by a concurrent increase (p<0.05) in extensor activation in order to maintain the quasi-static starting position. Following the onset of the reach, open loop (first 25ms) muscle activation was significant (p<0.05) for an ~12% increase in extensor

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activation that was attributed to initiation of the reach. Furthermore, closed loop (25ms to peak velocity) muscle activation was significant (p<0.05) for an ~20% increase in extensor activation that was attributed to intent to achieve maximum velocity. No additional flexor activation occurred during open or closed-loop time windows. In fact, synergistic flexor activation at the onset of lifting (15%) was nearly 4-fold and significantly greater (p<0.05) than the reflexive flexor activity (4%) in the closed loop portion of the reach indicating that reaching function is greatly more impacted by activation of the elbow flexors as part of flexion synergy than any subsequent increased activation of flexors due to stretch reflex. It should be acknowledged that the primary limitation of this work is the solely volitional nature of the reaching task that can introduce unavoidable performance variance. However, this work provides important justification for conducting future work that seeks to directly quantify stretch reflex contributions via velocity-controlled elbow perturbations under quasi-static abduction loading and dynamic reaching conditions.

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