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The Expression of Flexion Synergy Enhances Spasticity in Stroke

AUTHOR BLOCK: *J. SUNG¹, M. RAJABTABAR¹, B. MULYANA¹, H.-T. PENG¹, Y. YANG^{1,2,3};

¹Bioengineering, Univ. of Illinois at Urbana-Champaign, Urbana, IL; ²Clin. Imaging Res. Center, Stephenson Family Clin. Res. Institute, Carle Fndn. Hosp., Urbana, IL;

³Dept. of Physical Therapy and Human Movement Sciences, Northwestern Univ., Chicago, IL

Abstract:

Following a stroke, the contralateral arm on the opposite side of the damaged hemisphere exhibits abnormal co-activation of shoulder abductor and elbow flexor muscles, clinically known as the flexion synergy. Previous study suggested that the expression of flexion synergy may influence the already overactive stretch reflexes in affected elbow flexors. Therefore, this study aims to quantitatively analyze the impact of flexion synergy expression on elbow flexor stretch reflexes in stroke, in comparison to muscle pre-activation induced stretch reflexes in controls.

The early phase data collected in this study include two chronic stroke participants and three age-matched able-bodied control individuals. Stroke participants were precisely controlled for three levels of flexion synergy induced by shoulder abduction effort (0%, 20%, and 40% MVC) of the paretic arm. Simultaneously, a robotic device was utilized to induce stretch reflexes by extending the elbow at a sufficiently fast speed (peak value 270°/s) to evoke stretch reflex (50-150 ms). In the control group, voluntary elbow flexor pre-activation (0%, 20%, and 40% of maximum) was systematically induced to elicit muscle stretch reflexes for comparison with stroke patients.

It was observed that elbow flexor stretch reflexes were enhanced when stepwise increases in flexion synergy were induced by shoulder abduction in the paretic arm of stroke patients. Similarly, in the controls, stretch reflexes were found to increase based on the voluntary muscle pre-activation stage. However, flexion synergy induced stretch reflexes in stroke are larger than voluntary muscle pre-activation induced stretch reflexes. This result is different than the finding in a previous study where there is no significant difference between stroke flexion synergy induced stretch reflexes and control voluntary pre-activation induced stretch reflex. This is likely because in the previous study, stroke participants have various muscle tones, and their control group age is younger than stroke group.

The new result suggests that the expression of flexion synergy contributes to hyperactive stretch reflexes; thus, rehabilitation therapies aimed at reducing flexion synergy expression may alleviate spasticity during the everyday use of the arm in stroke patients.

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