Characterizations of Spasticity in Cerebral Palsy

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OBJECTIVES
More than 75% of children with the cerebral palsy (CP) may have significant spasticity. The mechanisms contributing to the upper motor neuron syndrome may be due to both neural and mechanical changes in the central and peripheral regions of neuromuscular systems. The increased resistance in spasticity can be due to hyperactive reflexes and/or nonreflex changes in muscles and soft tissues. However, there is a lack of methods and tools to characterize various reflex and non-reflex components quantitatively. The purpose of this study was to examine the ankle spasticity of children with CP. Both passive ankle stretching and Achilles tendon tapping were employed with a customized portable robotic system to quantify changes in reflex and non-reflex components.

METHODS

Main Equipment: An IntelliStretch Rehabilitation robot (Rehabtek LLC) and a Delsys EMG system were employed to examine reflex and nonreflex activities under both static and dynamic conditions.

Conditions: 1), Achilles tendon tapping at 0 degree ankle dorsiflexion; 2), Passive ankle joint movement at multiple speeds [80°/s, 180°/s, 210°/s], and the range of stretch was from 5° plantarfexion to 5° dorsiflexion.

Outcome variables: Tendon reflex impulse response with Tendon reflex gain, Contraction rate and Half relaxation rate; Response in stretching with Joint stiffness [Nm/°], Viscosity component [Nm.s/rad], Phasic reflex gain [Nm], Tonic reflex gain (Nm), Onset of EMG [ms], Peak EMG amplitude [mV], and Peak location [ms]

RESULTS
Normalized ankle stiffness in CP (3.74±2.95%) was higher than that of TDC (1.34±1.50%, P<0.017) and viscous torque in CP (0.37±0.244%) was higher (P< 0.05) than TDC (0.17±0.114, P=0.043) at 180°. The normalized phasic reflex torque in CP (0.649±0.331%) was higher than TDC (0.265±0.199, P=0.032) at 180°; tonic reflex torque was higher in CP (0.214±0.123%) than in TDC (0.070±0.042%) (P<0.01) at 55°. Tendon reflex gain (2.59±2.24%) for CP and 1.17±1.3% for TDC was higher (P<0.05) in CP than in TDC.

DISCUSSION
3) Clinical implications: A better understanding of multifactorial actions on spasticity help treat patients with CP more effectively. Our previous studies showed biomechanical and clinical improvements using the robotic system. Similar evaluations can be done for other therapy interventions including physical therapy, Botox, and/or baclofen.

4) Stretching assessments suggested suppressed reciprocal innervation which resulted in reflex activation of both agonist and antagonist muscles.

CONCLUSIONS
Various reflex and non-reflex components changed at the spastic ankle in children with CP, which may directly influence neuromuscular functions, including suppressed reciprocal innervation. The approach helps obtain separate quantitative evaluations of neural and biomechanical muscle/joint changes in CP, which may help guide more focused therapeutic treatments.

Disclosure
Li-Qun Zhang and Yupeng Ren hold equity positions in Rehabtek, which received federal grants in developing the rehabilitation robot used in the study.

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