A tensegrity-based soft exoskeleton improves the postural stability of children with cerebral palsy

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BACKGROUND Interventions in rehabilitation have been designed with the goal of minimizing impairments that alter the posture and movement of children with cerebral palsy (CP). Under such rational, a flexible exoskeleton, inspired on the fascial organization of the human body, was developed with the objective to provide extra support to the musculoskeletal system. The exoskeleton is based on the concept of tensegrity [1] and follows the architecture of the muscles and their fascial connections. Accordingly, it obeys the principles of tissue continuity, pre-stress and geodesic organization. We evaluated the effects of the tensegrity-based exoskeleton (TBS) on the postural stability of children with CP.

METHODS Participants were 10 children with normal development (ND) and 10 children with unilateral CP, ages 7-12 years, matched by sex and age. They were tested with the TBS and with a non-stressed body suit, as placebo, on the following conditions: (1) static maintenance of posture and (2) maintenance of posture in response to perturbation. The order of conditions was randomized for each participant. After TBS adjustments and familiarization, participants' postural stability was evaluated by means of the behavior of their center of pressure (CoP) oscillation measured by a force plate. Postural perturbation was produced by the release of a load (5% of the body mass) that was supported by children's upper limbs. Mixed ANOVAs for the x (medial-lateral) and the y axes (antero-posterior), under the static and perturbation conditions, tested the effects of group (CP, ND), suit (TBS, placebo) and *group x suit* interaction on: amplitude of the CoP, mean displacement of the CoP and root mean square of the CoP displacement.

RESULTS The results revealed that the tensegrity-based exoskeleton (TBS) was effective in improving postural stability of children with CP, decreasing oscillations, especially in the medial-lateral direction. Interestingly, children with normal development increased their oscillation in the TBS condition.

CONCLUSIONS Together, these results suggest that the improved postural stability observed in children with CP was not due to mechanical restrictions provided by the exoskeleton. On the contrary, as the human fascia, the TBS was capable to provide proper support without restricting the children's movement capability.

References

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This study was performed in accord with the institutional ethical policies and was approved by the University's ethical committee.