DYNAMIC STABILITY CONTROL AFTER FORWARD FALLS: MECHANISMS AND CONTRIBUTION OF TENDOMUSCULAR CAPACITIES
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Many studies reported that loss of muscle strength may alter the capacity of the human system to generate rapid force for balance corrections after sudden perturbations [2,3]. In agreement to these reports, we found that the muscle-tendon capacities of the lower limbs contribute about 33% to the balance recovery [1]. However, postural corrections after a sudden perturbation involve sensorimotor adaptational responses which include mechanisms responsible for maintaining the dynamic stability and thus muscle weakness may be partly compensated by proper planning and execution of the used locomotion strategy.

First, we investigated whether a decline in muscle strength, induced by fatiguing knee extension contractions, affects the mechanisms responsible for maintaining dynamic stability after a forward fall. Twenty two participants were instructed to regain balance with a single step after a sudden induced fall from a forward-leaning position before and after the fatigue. The fatigue related decrease in muscle strength did not affect the margin of stability, the boundary of the base of support or the position of the extrapolated centre of mass during the stance phase, indicating an appropriate adjustment of the motor commands to compensate the deficit in muscle strength. We concluded that the decrease in muscle strength after the fatiguing contractions do not lead to functional deficits while the forward falls demonstrating that this specific impairment of the musculoskeletal system cannot fully predict the postural performance.

In a second experiment we examined muscle strength and tendon stiffness of the leg-extensor muscle-tendon units as well as the recovery behaviour after a forward fall from a group (n=38) older adults. The participants who were not able to regain stability with a single step showed a lower base of support and a more anterior position of the extrapolated centre of mass during the phase from release until touchdown compared to the single steppers leading to a lower margin of stability at touchdown. However, the two groups did not differ in muscle strength and tendon stiffness showing that the muscle-tendon capacities may not be the only reason for balance corrections. The more anterior position of the extrapolated centre of mass and possibly the smaller base of support at touchdown for the unstable participants was associated to a higher horizontal ground reaction push-off force of the support limp in the second part of the phase until touchdown indicating a deficit in using mechanisms of dynamic stability. In summary the results give evidence that practicing motor tasks including the mechanisms responsible for dynamic stability control may allow older adults to learn and effectively use these mechanisms during sudden perturbations.

References