Novel Balance Platform: A Feasibility Study to Collect Normative Data

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Background
Every day activity requires the ability to react rapidly to external perturbations. However, even time-delayed balance ability may lead to more frequent falls. In particular, the reaction time (RT) of elderly people is increased by 27%, resulting in severe fall injuries or death\(^1\).

Purpose
The purpose of this study was therefore to evaluate the feasibility of muscle activity measurements on a novel balance platform and to collect first normative data of healthy subjects by determining RT of lower leg muscles to an external perturbation. It is hypothesized that muscular RT depends on the impact direction in the way that the agonist muscles (opposite to impact direction) are activated significantly earlier, but no differences are hypothesized depending on muscle location (anterior or posterior).

Method
The balance platform is fixed at each corner with a cable to a safety frame and can be displaced by two magnetic actuators in all directions of the horizontal plane (acceleration was set to 1.5g, translation to 5cm). Muscular activity of Tibialis Anterior (TibAnt) and Gastrocnemius Medialis (GastMed) was measured at nine subjects using surface EMG (Delsys, USA) while two times three impacts were conducted in anterior and posterior direction, respectively. An additional sensor was placed on the balance platform to simultaneously measure the acceleration thereof. Root-Mean-Square of the raw signal was calculated and timing of muscle activation after external perturbation was determined for every impact.

Results
RT of agonistic muscles (opposite to impact direction) of 97±25ms (TibAnt) and 99±11ms (GastMed) were significantly shorter than of antagonistic muscles (177±50ms for TibAnt and 216±93ms for GastMed, respectively; \(p<0.01\)). No general differences between RT of TibAnt and GastMed were observed (see Tab 1).

Discussion
Temporal activation of the muscles depended strongly on the impact direction regardless of whether anterior or posterior location. These findings are in line with the assumption that the agonistic musculature is needed to keep the balance immediately after external impact, while antagonistic muscles stabilize the ankle joint in reaction to agonistic contraction.

Prospects
In order to get a reliable normative data pool, measurements with more subjects will be conducted in the near future. First measurements with elderly people with and without fall history and a case study with a Parkinson patient are planned. Beyond, the novel balance plate shall be used for pre and post testing of balance training interventions.

Reference: