PURPOSE: The compensation for a sudden balance perturbation, unpracticed and unpredictable in timing and magnitude, the so called first-trial reaction, is accompanied by pronounced postural instability that is suggested to be causal to falls. However, even though it is well established that the cerebral cortex is essentially involved in the control of balance and upright posture, the cortical processes underlying the first-trial reaction are still unknown. Therefore, this study aimed to identify cortical characteristics during the first-trial reaction that would provide further insights into neural processes associated with falls.
METHODS: 37 subjects (age: 24.7±3 years; body weight: 77.3±8.1 kg; height: 180.4±5.1 cm; body mass index: 23.8±2.4) were exposed to ten transient balance perturbations induced by a sideward movement of the supporting platform. Cortical activity was recorded using a 32-channel EEG-system. Postural instability was determined by platform movements and EMG activity of the m. peroneus during the first second following perturbation. Amplitude and latency of cortical P1 and N1 potentials were analyzed for trial by trial. P1 and N1 potentials were localized by LORETA transformation.
RESULTS: P1 and N1 potentials were located in Brodmann area 5 and 6, respectively. The P1 potential remained unchanged in amplitude or latency over trials. In contrast, first-trial effects were observed for N1 amplitude in frontal and parietal electrodes. Specifically, there was a significant decrease in N1 amplitude from trial 1 to trial 2. Furthermore, habituation effects were indicated by a reduction of N1 latency over trails. EMG data indicated a decrease of muscular activity from trial 1 to trial 2 in both legs and this was accompanied by a reduction of platform oscillations.
CONCLUSION: It is concluded that first-trial reactions to unpredictable perturbations are accompanied by unique characteristics in cortical activity. The P1 is suggested to reflect the initial sensory response to perturbation-induced afferent feedback while the N1 is associated with error-detection and processing.

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Tortuosity as a Novel Assessment Tool of Dynamic Balance

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The Star Excursion Balance Test (SEBT) is a commonly used dynamic balance test that measures performance and injury risk among active populations. Tortuosity describes how twisted or how much curvature is present in an observed movement or path.
PURPOSE: The purpose of this study was to introduce the three-dimensional(3D) tortuosity of foot, shank, and thigh segments as a metric for SEBT.
METHODS: Fifteen healthy participants completed this study (age 21.4±1.9 years, height 169.4±10.0 cm, weight 67.7±13.7 kg). Participants completed the SEBT with three-dimensional motion analysis using an 8 camera BTS Smart 7000DX motion analysis system. The tortuosity of stance limb retroreflective markers was then calculated and compared between reach directions using a 1x3 ANOVA with repeated measures while the relationship between SEBT performance and tortuosity was established using Pearson product moment correlations.
RESULTS: ASIS tortuosity was significantly greater (P=.001 and .001) and lateral knee tortuosity was significantly lesser (P =.018 and .034) in the anterior direction when compared with both the posteromedial and posterolateral directions respectively. In addition, 2nd metatarsal tortuosity was greater in the anterior reach direction when compared to posteromedial direction (P =.048). Greater SEBT anterior reach distance was significantly correlated with lesser 2nd metatarsal head marker tortuosity (r=-.562, P=.037), greater posteromedial reach distance was correlated with lesser ASIS marker tortuosity (r=-.576, P =.039), and greater posterolateral reach distance was correlated with greater calcaneal marker tortuosity (r=-.560, P=.040). In addition, anterior ($R2$=.315, P=.037), posteromedial ($R2$=.573, P=.014), and posterolateral reach distance were all significantly predicted by marker tortuosity ($R2$ =.313, P=.037).
CONCLUSIONS: Tortuosity is a novel measurement technique that estimates segmental movement during common dynamic tasks such as the SEBT. This enhanced level of detail compared to more global measures of joint kinematic may provide insight into compensatory movement strategies adopted following lower extremity joint injury.

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A Prospective Evaluation of Postural Stability During the Transition from Double-leg Stance to Single-leg Stance

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PURPOSE: Female athletes are at increased risk for non-contact knee and ankle injuries. Postural stability deficits have retrospectively been shown in subjects after knee and ankle injuries during the transition from double-leg stance to single-leg stance, but it remains unclear whether these impairments are the consequence or the cause of these injuries. The purpose of the present study was to prospectively investigate whether postural stability during the transition from double-leg stance to single-leg stance can predict non-contact knee and ankle injuries in female athletes.
METHODS: Fifty injury-free female athletes participated in the study and performed the transition from double-leg stance to single-leg stance in eyes closed conditions while standing on a single force plate. The center of pressure displacement during the first three seconds after a new stability point (TAT) during the single-leg stance phase was the main outcome variable. Time loss non-contact knee and ankle injuries were registered during a one-year follow-up. The injured and non-injured legs of the group who sustained an injury were matched with the corresponding leg of the non-injured group. Independent t-tests were used to compare the injured and non-injured group. The area under the receiver operating characteristic (ROC) curves (AUC) was analyzed to qualify the predictive ability of the TAT outcome.
RESULTS: Nine subjects sustained a time loss non-contact knee or ankle injury. Four other subjects were excluded because of other injury mechanisms. TAT was significantly increased in the injured (P = .016) and non-injured leg (P = .006) of the injured group compared to the respective matched leg of the non-injured group. The ROC analysis showed a significant discriminative accuracy between groups for TAT of the injured (AUC = 0.721; P = .043) and non-injured leg (AUC = 0.770; P = .018) of the injured group with the matched leg of the non-injured group.
CONCLUSIONS: Female athletes with decreased postural stability during the transition from double-leg stance to single-leg stance are at increased risk to sustain non-contact knee and ankle injuries.

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Comparison of Limits of Stability Testing on Static and Dynamic Surfaces

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Limits of stability (LOS) testing typically involves moving the total body center of mass (TBCM) over the base of support (BOS) to targets positioned within the theoretical LOS. Research has examined LOS testing on static and dynamic (unstable) surfaces, however different testing devices were used, thus confounding data interpretation. Additionally, whether performance on static and dynamic surfaces is related remains inconclusive.
PURPOSE: To compare TBCM to BOS distances and relationships between double leg LOS testing on static and dynamic surfaces.
METHODS: Healthy men (n=4) and women (n=5) aged 20 to 27 yrs completed static and dynamic (unstable level 8) surface LOS testing, on the Biodex SD (Biodex, Inc., Shirley, NY). A screen displayed eight targets, positioned at 75% of the subject's theoretical LOS around a central target, and the instantaneous location of center of pressure (static) or platform orientation (dynamic). Randomly, a target became highlighted and the subject was cued to reach the target by leaning their body. Three trials of each surface/target were completed. TBCM was computed using kinematic data of 13 body segments. Closest horizontal distance between the TBCM projection on the support surface and BOS was computed upon reaching each target.