



POSTER ABSTRACTS

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BACKGROUND AND AIM: Fall injuries are responsible for significant disability among elderly[1]. Exergames based on full body movements provide a challenging opportunity for training and evaluation of postural control[2], but affordable sensor technology and algorithms for assessment of whole body movement patterns are scarce. Aim: to evaluate the suitability of Kinect, an affordable motion capture system (MCS), for evaluation of balance ability during exergaming. To this end we compared Kinect with a marker based (MB) MCS by 1) detecting common features in whole body MCS data, 2) identifying the contribution of individual anatomical landmarks (ALs) to movement patterns, and 3) by computing outcome measures representing balance ability. We hypothesize that the MB MCS outperforms Kinect, but that evaluation of movement patterns by Kinect is feasible. **METHODS:** Twenty healthy adults (age 36.95 ± 16.64) performed five different 1-min task-embedded mediolateral weight-shift exergame trials while 2D position data of 10 ALs in the frontal plane was obtained using a 12 camera Vicon V8 system and Kinect. Game conditions included: neutral, lifting a leg and increased game speed, sway amplitude (SA) and sway frequency (SF). Principal Component Analysis (PCA)[3] was performed on normalized Vicon and Kinect data. Common features were identified by projecting data on the three main principal components (PCs). Vicon and Kinect data were combined in a PCA and the contribution of each AL to the three main PCs was quantified by eigenvector analysis. Finally, outcome measures representing balance ability, including SA, SF, RMS and index of harmonicity (IH)[4], were computed from identified common features. **RESULTS:** Variance explained (VE) by common features for Vicon and Kinect is $94.3 \pm 3.8\%$ and $93.6 \pm 3.3\%$ respectively, indicating that both systems can cover most of the signal features within three PCs. The contribution of ALs to the movement patterns showed differences in VE ranging from 5% for trunk ALs up to 25% for extremities in all conditions. Differences ranging 4-52% were observed for SA, RMS and IH, while SF difference was within 1-6% range (fig1). **CONCLUSION:** For the first time PCA was used to compare movement patterns during exergaming. Kinect and Vicon identify common features in MCS data with similar accuracy. However, differences in the contribution of ALs to PCs are observed between devices, thereby affecting accuracy of balance evaluation. These limitations should be taken into account when adopting Kinect for whole body motion capture for balance assessment during exergaming. 1. Sterling DA, et al. J. Trauma 2001, 50:116-9 2. Van Diest M, et al J. Neuroeng. Rehabil. 2013, 10:101 3. Daffertshofer A, et al. Clin. Biomech. 2004, 19:415-28 4. Lamoth CJC, et al. Gait Posture 2002, 16:101-14 Fig1. Balance outcome measures computed from Vicon and Kinect PCA projections along the three main PCs. Vicon and Kinect are indicated by black and grey bars respectively

P2-R-129 Rotation Amplitude Dependency of the Intrinsic Ankle Stiffness during Standing

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BACKGROUND AND AIM: To ensure upright balance the ankle joint stiffness must be sufficient to resist the gravitational pull. This stiffness arises from both intrinsic and reflexive components. Determining their individual contribution might give insight in neuromuscular and balance related disorders. Ankle joint stiffness is often investigated by fitting a parametric model to a torque response, obtained from an



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applied joint rotation. Direct, non-parametric estimation is often not applicable because the applied rotations cannot rule out reflex activity. Here the rotational amplitude dependency of the intrinsic ankle stiffness was estimated in standing, using fast ramp-and-hold stretches to circumvent reflexive contributions. METHODS: Eight healthy subjects participated in the study. Subjects stood on the Bilateral Ankle Perturbator (BAP, figure top), with which 0.08-0.005 rad plantar- and dorsiflexion rotations were applied to the individual ankle joints. Rotations consisted of 40 ms ramp-and-hold minimum jerk profiles [1]. The intrinsic stiffness was obtained by dividing the difference in torque exerted on the platform before and after rotation onset by the rotational amplitude. These values were normalized to the critical stiffness [2]. EMG data of the triceps surae and tibialis anterior muscles were recorded to investigate reflex activity. RESULTS: The EMG signals of the stretched muscles showed short latency reflex activity starting approximately 5 ms after the rotation ended (figure middle). The EMG of the gastrocnemius medialis is shown. The intrinsic ankle stiffness decreased non-linearly with increasing rotation amplitude. There was no significant difference in stiffness between plantar- and dorsiflexions. A fit to all subjects' pooled data in comparison with other values in literature [2-4] is shown (figure bottom). CONCLUSIONS: The intrinsic ankle stiffness is insufficient to ensure balance, hence changes in muscle activation are required to realize upright stance. Reflex activity is not expected to have influenced the stiffness estimates due to the short latency of the perturbations and the electro-mechanical delay of muscle tissue. The decrease in stiffness is attributed to muscle cross-bridge breakage leading to sliding of filaments, decreasing the overall stiffness. References: [1] Burdet e.a.-2000-J.Biomech. [2] Casadio e.a.-2005-Gait Posture [3] Loram e.a.-2002-J.Physiol. [4] Loram e.a.-2007-J.Physiol.

P2-R-130 Correct method to measure knee angle in standing phase of gait

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[Background and aim] Gait analysis is performed on a routine work by clinicians, physical therapist and researchers. A known validate methods are 3-dimension electronic motion analysis and electrical goniometer. They aren't used frequently in clinic and hospital as too expensive. And, to measure the knee angle, usually marks are attached to the greater trochanter, lateral epicondyle of femur, and lateral malleolus. However, knee axis is known as flexible moving shaft during gait and other motions, and soft tissue artifacts are commonly considered the most troublesome source of error in measurements of human motion carried out using stereo-photogrammetry. In case of electrical goniometer, thigh fixed with bandage to attach the lever arm. There is a possibility that knee angle do not be measured exactly for these problems. The aim of this research was to establish the correct method to measure knee angle in standing phase of gait. [Method] Five young females participate in experiments. We developed the new following methods and carried it out by the method. Marks are attached to proximal 1/3 and 2/3 of the femur, and proximal 1/3 and 2/3 of the lower leg. Angle between a straight line passing through the two points of femur and lower leg were measurement as knee angle. And, we measure by two the traditional method, too. [Results] In the traditional method, the knee bending angle of mid stance phase is larger than our new method, and knee extension angle of initial contact and acceleration phase is less than our new method. Overall, the traditional method of the knee angle change is calculated large, our new method is calculated small. [Conclusions] Than before, humans take so-called double knee action in one gait cycle. But, our new method doesn't show