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Validity of the microsoft kinect system in assessment of compensatory stepping behavior during standing and treadmill walking

Guy Shani[1], Amir Shapiro[2], Goldstein Oded[1], Kagan Dima[1] and Itshak Melzer[3*]

Abstract

Background: Rapid compensatory stepping plays an important role in preventing falls when balance is lost; however, these responses cannot be accurately quantified in the clinic. The Microsoft Kinect™ system provides real-time anatomical landmark position data in three dimensions (3D), which may bridge this gap.

Methods: Compensatory stepping reactions were evoked in 8 young adults by a sudden platform horizontal motion on which the subject stood or walked on a treadmill. The movements were recorded with both a 3D-APAS motion capture and Microsoft Kinect™ systems. The outcome measures consisted of compensatory step times (milliseconds) and length (centimeters). The average values of two standing and walking trials for Microsoft Kinect™ and the 3D-APAS systems were compared using *t*-test, Pearson's correlation, Altman-bland plots, and the average difference of root mean square error (RMSE) of joint position.

Results: The Microsoft Kinect™ had high correlations for the compensatory step times ($r = 0.75–0.78$, $p = 0.04$) during standing and moderate correlations for walking ($r = 0.53–0.63$, $p = 0.05$). The step length, however had a very high correlations for both standing and walking ($r > 0.97$, $p = 0.01$). The RMSE showed acceptable differences during the perturbation trials with smallest relative error in anterior-posterior direction (2-3%) and the highest in the vertical direction (11–13%). No systematic bias were evident in the Bland and Altman graphs.

Conclusions: The Microsoft Kinect™ system provides comparable data to a video-based 3D motion analysis system when assessing step length and less accurate but still clinically acceptable for step times during balance recovery when balance is lost and fall is initiated.

Keywords: Balance, Older adults, Compensatory stepping, Falls, The Microsoft Kinect™

Background

The ability to perform rapid compensatory balance reactions (i.e., stepping movement) when balance is lost has been linked to fall risk in older adults [1–3]; however, the assessment of these reactions is commonly undertaken in a laboratory. Measurement tools for assessing compensatory balance reactions include force platforms, electromyography systems, as well as full-body three dimensional (3D) kinematic assessments [1–4]. The examination of compensatory stepping behavior utilizes expensive motion analysis equipment to analyze those balance reactions that would not be available to most elderly individuals or even rehabilitation clinics.

With regard to clinic-based assessments, there are simple objective clinical measures of balance control, such as Berg Balance Scale, Timed get up and go, and Short Physical Performance Battery. These measures include clinician assessments of quality of movement, and timing using a stopwatch. While providing useful information to the clinician, they are prone to ceiling effects and often cannot accurately quantify the postural control

* Correspondence: itzikm@bgu.ac.il
[3]Schwartz Movement Analysis & Rehabilitation Laboratory, Physical Therapy Department, Recanati School for Community Health Professions, Faculty of Health Sciences, Ben-Gurion University of the Negev, P.O.B. 653, Beer-Sheva 84105, Israel
Full list of author information is available at the end of the article