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Reliability and validity of the Kinect V2 for the assessment of lower extremity rehabilitation exercises

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ABSTRACT

Background: Besides its initial use as a video gaming system the Kinect might also be suitable to capture human movements in the clinical context. However, the system's reliability and validity to capture rehabilitation exercises is unclear.
Research question: The purpose of this study was to evaluate the test-retest reliability of lower extremity kinematics during squat, hip abduction and lunge exercises captured by the Kinect and to evaluate the agreement to a reference 3D camera-based motion system.
Methods: Twenty-one healthy individuals performed five repetitions of each lower limb exercise on two different days. Movements were simultaneously assessed by the Kinect and the reference 3D motion system. Joint angles and positions of the lower limb were calculated for sagittal and frontal plane. For the inter-session reliability and the agreement between the two systems standard error of measurement (SEM), bias with limits of agreement (LoA) and Pearson Correlation Coefficient (r) were calculated.
Results: Parameters indicated varying reliability for the assessed joint angles and positions and decreasing reliability with increasing task complexity. Across all exercises, measurement deviations were shown especially for small movement amplitudes. Variability was acceptable for joint angles and positions during the squat, partially acceptable during the hip abduction and predominately inacceptable during the lunge. The agreement between systems was characterized by systematic errors. Overestimations by the Kinect were apparent for hip flexion during the squat and hip abduction/adduction during the hip abduction exercise as well as for the knee positions during the lunge. Knee and hip flexion during hip abduction and lunge were underestimated by the Kinect.
Significance: The Kinect system can reliably assess lower limb joint angles and positions during simple exercises. The validity of the system is however restricted. An application in the field of early orthopedic rehabilitation without further development of post-processing techniques seems so far limited.

1. Introduction

Conventional 3D motion analysis systems consisting of multiple infrared cameras, reflective or illuminated markers and data analysis software are widely used to assess kinematics of body segments and the according joints. The field of application is broad and includes rehabilitation research, injury prevention and performance enhancement [1–3]. However, the acquisition of the system is expensive, data assessment and analysis time consuming and requires trained staff. Additionally, motion capturing is restricted to a laboratory environment. Marker-less motion capture systems like the Microsoft Kinect technology might offer a portable, low cost and easy to operate system for applications outside the laboratory. Besides its initial use as a video gaming system, new possibilities for the application in the clinical context were discussed to assist rehabilitation and the evaluation of therapy process [4]. First investigations on the feasibility and effect of interactive systems for the enhancement of functional parameters in clinical populations were promising. Research in motor rehabilitation

Abbreviations: f/e, flexion/extension; m/l, medial/lateral; a/p, anterior/posterior; ab/ad, abduction/adduction; bas, baseline (initiation of movement); max/min, value at maximum/minimum excursion of movement

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