

# First in vivo assessment of “Outwalk”: a novel protocol for clinical gait analysis based on inertial and magnetic sensors

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59

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## Abstract

A protocol named “Outwalk” was recently proposed to measure the thorax–pelvis and lower-limb kinematics during gait in free-living conditions, by means of an inertial and magnetic measurement system (IMMS). The aim of this study was to validate Outwalk on four healthy subjects when it is used in combination with a specific IMMS (Xsens Technologies, NL), against a reference protocol (CAST) and measurement system (optoelectronic system; Vicon, Oxford Metrics Group, UK). For this purpose, we developed an original approach based on three tests, which allowed to separately investigate: (1) the consequences on joint kinematics of the differences between protocols (Outwalk vs. CAST), (2) the accuracy of the hardware (Xsens vs. Vicon), and (3) the summation of protocols’ differences and hardware accuracy (Outwalk + Xsens vs. CAST + Vicon). In order to assess joint-angles similarity, the coefficient of multiple correlation (CMC) was used. For test 3, the CMC showed that Outwalk + Xsens and CAST + Vicon kinematics can be interchanged, offset included, for hip, knee and ankle flexion–extension, and hip ab-adduction (CMC > 0.88). The other joint-angles can be interchanged offset excluded (CMC > 0.85). Tests 1 and 2 also showed that differences in

offset between joint-angles were predominantly induced by differences in the protocols; differences in correlation by both hardware and protocols; differences in range of motion by the Xsens accuracy. Results thus support the commencement of a clinical trial of Outwalk on transtibial amputees.

## Keywords

Gait analysis Kinematics Protocol Ambulatory Inertial sensors  
Magnetic sensors Cerebral palsy Amputee

## Electronic supplementary material

The online version of this article (doi:[10.1007/s11517-009-0544-y](https://doi.org/10.1007/s11517-009-0544-y)) (<https://doi.org/10.1007/s11517-009-0544-y>) contains supplementary material, which is available to authorized users.

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# Supplementary material

[11517\\_2009\\_544\\_MOESM1\\_ESM.pdf](#) (114 kb)  
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