

RESEARCH ARTICLE

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# Validation of inertial measurement units with optical tracking system in patients operated with Total hip arthroplasty

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## Abstract

**Background:** Patient reported outcome measurement (PROMs) will not capture in detail the functional joint motion before and after total hip arthroplasty (THA). Therefore, methods more specifically aimed to analyse joint movements may be of interest. An analysis method that addresses these issues should be readily accessible and easy to use especially if applied to large groups of patients, who you want to study both before and after a surgical intervention such as THA. Our aim was to evaluate the accuracy of inertial measurement units (IMU) by comparison with an optical tracking system (OTS) to record pelvic tilt, hip and knee flexion in patients who had undergone THA.

**Methods:** 49 subjects, 25 males 24 females, mean age of 73 years (range 51–80) with THA participated. All patients were measured with a portable IMU system, with sensors attached lateral to the pelvis, the thigh and the lower leg. For validation, a 12-camera motion capture system was used to determine the positions of 15 skin markers (Oqus 4, Qualisys AB, Sweden). Comparison of sagittal pelvic rotations, and hip and knee flexion-extension motions measured with the two systems was performed. The mean values of the IMU's on the left and right sides were compared with OTS data.

**Results:** The comparison between the two gait analysis methods showed no significant difference for mean pelvic tilt range (4.9–5.4 degrees) or mean knee flexion range (54.4–55.1 degrees) on either side ( $p > 0.7$ ). The IMU system did however record slightly less hip flexion on both sides (36.7–37.7 degrees for the OTS compared to 34.0–34.4 degrees for the IMU,  $p < 0.001$ ).

**Conclusions:** We found that inertial measurement units can produce valid kinematic data of pelvis- and knee flexion-extension range. Slightly less hip flexion was however recorded with the inertial measurement units which may be due to the difference in the modelling of the pelvis, soft tissue artefacts, and malalignment between the two methods or misplacement of the inertial measurement units.

**Trial registration:** The study has ethical approval from the ethical committee "Regionala etikprövningsnämnden i Göteborg" (Dnr: 611–15, 2015-08-27) and all study participants have submitted written approval for participation in the study.

**Keywords:** Inertial measurement units, IMU's, Optical tracking system, Total hip arthroplasty, Gait, Gait analysis

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