Determination of gait parameters based on multi-sensors

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Purpose Gait analysis is an important method to evaluate the function of the human body, such as mobility, flexibility, stability, and functional strength. Most previous studies used the 3D motion capture system to calculate gait parameters in the gait laboratory. The 3D motion capture system is very accurate to determine the gait parameters and useful to apply to the various experimental protocols synchronizing with the other devices. However, it had spatial- disadvantages and is expensive to be used for the elderly and the patient[1], [2]. In this study, gait parameters were calculated using the multi-sensor, and were compared with those of the 3D motion capture system. **Method** Ten healthy adults were asked to perform level walking. Inertial measurement units (IMUs; Xsens DOT; 60Hz) and force plates (KISTLER & AMTI; 1000Hz) were used to determine gait parameters: knee joint angle and ankle joint moment. Four IMUs were attached on the lateral side of both thighs and shanks (left& right). 3D motion capture system (Vicon Motion System Ltd, Oxford, UK; 200Hz) was used as the reference data with the plug-in-lower-body marker set. Knee joint angle was calculated by the difference between the Euler angles of two IMUs (thigh and shank) using the quaternion algorithm. The ground reaction force and the center of pressure with the coordinate data of the ankle joint were used to calculate the ankle joint moment. Knee joint angles of the multi-sensor and 3D motion capture system were normalized to be 0° at the initial contact. The normalization of the ankle joint moment was carried out using each subject's weight. Gait parameters of the multi-sensor were compared with those of 3D motion capture system in each gait event (Initial contact (IC), Foot flat (FF), Heel off (HO), Toe off (TO)). The correlation coefficient was calculated to analyze the similarity between the multi-sensor and 3D motion capture system. **Results and Discussion** In knee joint angle, the differences between the multi-sensor and 3D motion capture system were 2.71°±1.80 (FF), 2.72°±1.06 (HO), and 6.04°±2.93 (TO) respectively (Figure 1). The correlation coefficient of the knee joint angle was 0.9644. The difference of ankle joint moment between the multi-sensor and the 3D motion capture system were 0.010±0.003Nm/kg (IC), 0.043±0.024Nm/kg (FF), 0.051±0.030Nm/kg (HO), and 0.039±0.012m/kg (TO) respectively (Figure 2). Ankle joint moments determined by the two systems showed a strong correlation of 0.9963, which supported that the multi-sensor system could be used to replace the 3D motion capture system to determine gait parameters.

References

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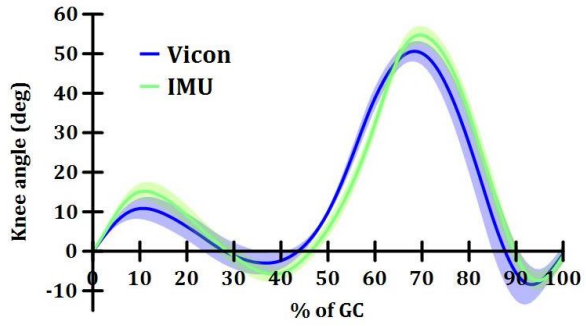

Figure 1. *Knee joint angle (Blue: Reference Knee angle, Green: Calculated Knee angle using IMU)*

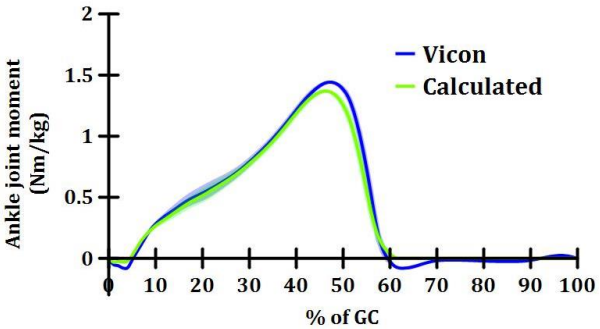

Figure 2. *Ankle joint moment (Blue: Reference Ankle joint moment, Green: Calculated Ankle joint moment using Force plate)*