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Case report : The usefulness of IMU-based Gait analysis in patients with disabilities

Jun Hee Lee[1*], Aeri Jang[1], Hasuk Bae[1†]

Ewha Womans University Mokdong Hospital, Department of Rehabilitation Medicine [1]

On evaluating one's functional mobility, the most popular and widespread method is marker-based motion capture technology by using infrared camera. However, there are some limitations inherent in data recruitment in specific settings and environments. It needs to use an array of cameras, marker-based motion capture is not available in patients with handling assistive devices such as walkers, crutches and canes. Because these are considered as obstacles, the accuracy of assesment is decreased. Also, settings with not flattened area such as a patient's home, on the field, or in public is not included in option. One potential solution that has been suggested is to use a markerless motion capture system, for instance, inertial measurement unit (IMU) technology.

Recent study shows utilizing IMU technology to gait analysis with disabled patients who cannot walk without assist. With IMU technology, it becomes enable to carry on quantitative analysis of gait patterns with patients, who needs handling assistive devices. Also, it allows broader range of environments, so gait analysis on the slope or outdoor is available in virtue of its markerless system. IMU-based gait analysis allows quantitative evaluation of disabled patients' gait pattern and helps determining best fitting assistive devices for rehabilitation.

There are examples of IMU-based gait analysis with in-hospital patiens, who cannot walk independently. Gait patterns were evaluated on transfer day to decide the most suitable assistive device. First, IMU sensor provided to patients' abdomen, both thigh, shank and foot dorsum. Figure1. And next, calibration of axis was done. Then, patients gait 6m with several assistive devices with video monitoring. During the gait, gait parameters and degrees of hip, knee joint and ankle joints in sagittal, coronal and transverse plane are detected. If the result showed no significant difference between two gait analysis, superior level handling devices was adapted. In contrast, if there was difference, inferior level handling devices was adapted.

Case 1 was patient with chronic subdural hemorrhage at left cerebral convexity, status post burr hole operation, with recent infarction at right side pons. There is no significant differences of gait parameters and joint angle between quad cane gait and monocane gait, as shown in figure 2. So, this patients assistive device was decided to monocane.

Case 2 was patient with spondylodiscitis, L3-4 with abscess at subcutaneous fat layer, L3-4, status post L3/4 spinal abscess removal operation. There was clear difference between walker gait and quad cane gait. The stride length is longer and both knee joint angle(sagittal) is closer to normative range in walker gait, as shown in figure 3. Therefore, in this case, patients assistive device was determined as walker.

In conclusion, IMU-based gait analysis is useful with evaluating disabled patients' gait patterns quantitatively with accuracy.

Fig 1. IMU-based gait evaluation

	Quad cane		Monocane	
	Lt.	Rt.	Lt.	Rt.
Gait cycle time(sec)	1.3	1.3	1.3	1.3
stance : swing phase	5.6:4.4	5.7:4.3	5.6:4.4	5.2:4.8
Velocity(m/s)	0.1	0.4	0.4	0.6
Stride length(m)	0.1	0.2	0.1	0.3

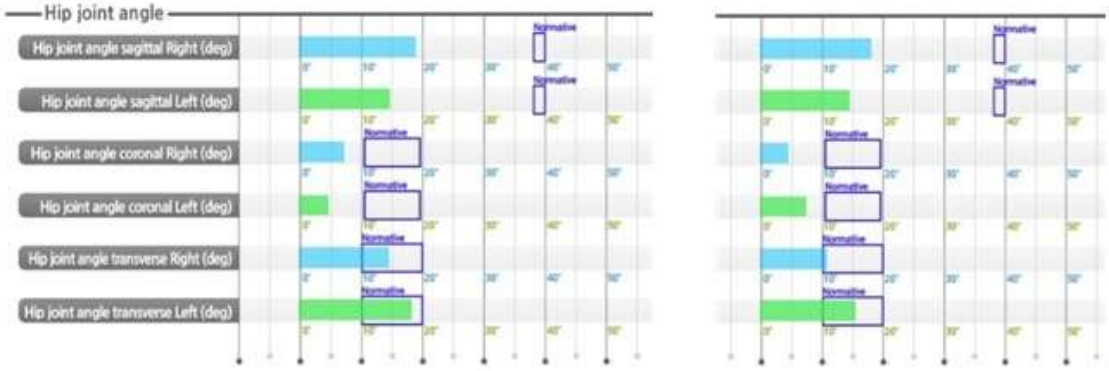

Fig 2. Gait parameters and Degrees of hip joint : Quadcane vs. monocane, Case 1

	Walker		Quad cane	
	Lt.	Rt.	Lt.	Rt.
Gait cycle time(sec)	1.7	1.7	2.4	2.5
stance : swing phase	5.7:4.3	5.8:4.2	6.1:3.9	6.3:3.7
Velocity(m/s)	0.6	0.6	0.4	0.4
Stride length(m)	0.5	0.5	0.2	0.3

Fig 3. Gait parameters and Degrees of knee joint : Walker vs. quadcane, Case 2