The Biomechanical Assessment of Balance and Gait for Stroke Patients and the Implications in the Diagnosis and Rehabilitation

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Abstract : Background: Stroke commonly occurs in middle-aged and elderly populations, and the diagnosis of early stroke is still difficult. Patients who have suffered a stroke have different balance and gait patterns from healthy people. Advanced techniques of motion analysis have been routinely used in the clinical assessment of cerebral palsy. However, so far, little research has been done on the direct diagnosis of early stroke patients using motion analysis. Objectives: The aim of this study was to investigate whether patients with stroke have different balance and gait from healthy people and which biomechanical parameters could be used to predict and diagnose potential patients who are at a potential risk to stroke. Methods: Thirteen patients with stroke were recruited as subjects whose gait and balance was analysed. Twenty normal subjects at the matched age participated in this study as a control group. All subjects' gait and balance were collected using Vicon Nexus® to obtain the gait parameters, kinetic, and kinematic parameters of the hip, knee, and ankle joints in three planes of both limbs. Participants stood on force platforms to perform a single leg balance test. Then, they were asked to walk along a 10 m walkway at their comfortable speed. Participants performed 6 trials of single-leg balance for each side and 10 trials of walking. From the recorded trials, three good ones were analysed using the Vicon Plug-in-Gait model to obtain gait parameters, e.g., walking speed, cadence, stride length, and joint parameters, e.g., joint angle, force, moments, etc. Result: The temporal-spatial variables of Stroke subjects were compared with the healthy subjects; it was found that there was a significant difference ($p < 0.05$) between the groups. The step length, speed, cadence were lower in stroke subjects as compared to the healthy groups. The stroke patients group showed significantly decreased in gait speed (mean and SD: 0.85 ± 0.33 m/s), cadence (96.71 ± 16.14 step/min), and step length (0.509 ± 017 m) in compared to healthy people group whereas the gait speed was 1.2 ± 0.11 m/s, cadence 112 ± 8.33 step/min, and step length 0.648 ± 0.43 m. Moreover, it was observed that patients with stroke have significant differences in the ankle, hip, and knee joints' kinematics in the sagittal and coronal planes. Also, the result showed that there was a significant difference between groups in the single-leg balance test, e.g., maintaining single-leg stance time in the stroke patients showed shorter duration (5.97 ± 6.36 s) in compared to healthy people group (14.36 ± 10.20 s). Conclusion: Our result showed that there are significantly differences between stroke patients and healthy subjects in the various aspects of gait analysis and balance test, as a consequences of these findings some of the biomechanical parameters such as joints kinematics, gait parameters, and single-leg stance balance test could be used in clinical practice to predict and diagnose potential patients who are at a high risk of further stroke.

Keywords : gait analysis, kinetics, kinematics, single-leg stance, Stroke