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Decomposition of Leg Motions During Over Ground Walking in Individuals with Traumatic Brain Injury

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Walking is an essential activity of daily living in humans. Successful performance of this task requires precise temporal coordination of lower extremities, composed of several joints and segments. Motions at the ipsi- and contralateral leg joints must be initiated, continued and terminated simultaneously with switching activity at certain phases of the gait cycle to allow smooth body progression in the desired direction without loss of balance. The ability to coordinate movements can be affected after a traumatic brain injury (TBI). The purpose of the present study was to investigate the effects of brain injury on inter-joint coordination of the legs during over ground walking. Ten individuals with TBI (7 males; mean age± SD standard deviation, SD, 45.2 ±12.78 years, ranging from 26-66 years of age), and 10 healthy sex- and age- matched participants (mean age± SD,44.0 ±14.43 years, ranging from 25-66 years of age) without known neurological, orthopedic, or cognitive deficits participated in the study. Participants with TBI presented with some degree of ataxia, as well as postural and gait abnormalities, with their clinical test score ranged: a) 2–18 points (mean ± SD: 7.9 ± 6.1 points) on the Ataxia Test by Klockgether; b) 45–54 points (mean ± SD: 51.0 ± 3.6 points) on the Berg Balance Scale and c) 14–27 points (mean ± SD: 22.8 ± 4.3 points) on the Functional Gait Assessment Test. All participants walked a 12-m distance at self-selected speed in three experimental conditions: normal walking without any additional task; walking with the narrow base of support, and walking while holding a cup full of water. Participants' movements during walking were recorded with a 12-camera Vicon T160 Motion Capture system at 100 Hz with 39 markers, placed according to the Plug-in-Gait Full Body Model. Inter-joint leg coordination was analyzed as the percentage of gait cycle during which the leg motion was decomposed, with 0% indicating simultaneous motions at the two joints (i.e. hip-knee, knee-ankle, and hip-ankle) or 100% indicating motion of only one joint at the time. Decomposition was calculated for each pair of joints and for the left and right leg separately. Participants with TBI showed greater decomposition indices than control individuals for all joint pairs ($p < 0.01$). The inter-joint coordination was even more affected in participants with TBI, when walking was challenged by narrowing a base of support or holding a cup. Results may indicate impaired mechanisms of inter-joint coordination following TBI or presence of compensatory strategies to improve walking. These abnormalities should be taken into consideration while planning physical therapy programs for individuals after brain injury.