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Wearable Electronics Assess the Effectiveness of Transcranial Direct Current Stimulation on Balance and Gait in Parkinson's Disease Patients

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Abstract: Currently, clinical evaluation represents the primary outcome measure in Parkinson's disease (PD). However, clinical evaluation may underscore some subtle motor impairments, hidden from the visual inspection of examiners. Technology-based objective measures are more frequently utilized to assess motor performance and objectively measure motor dysfunction. Gait and balance impairments, frequent complications in later disease stages, are poorly responsive to classic dopamine-replacement therapy. Although recent findings suggest that transcranial direct current stimulation (tDCS) can have a role in improving motor skills, there is scarce evidence for this, especially considering the difficulty to objectively assess motor function. Therefore, we used wearable electronics to measure motor abilities, and further evaluated the gait and balance features of 10 PD patients, before and (three days and one month) after the tDCS. To assess patients' abilities, we adopted six motor tasks, obtaining 72 meaningful motor features. According to the obtained results, wearable electronics demonstrated to be a valuable tool to measure the treatment response. Meanwhile the improvements from tDCS on gait and balance abilities of PD patients demonstrated to be generally partial and selective.

Keywords: balance; gait; Parkinson's disease; transcranial direct current stimulation; wearable electronics; IMUs

1. Introduction

Wearable electronics are gaining increasing attention and importance as a valid tool for healthcare practitioners in medical treatment [1–3] and patient monitoring [4–6]. In particular, wearable sensors have been applied for assessing the motor performance of patients with neurodegenerative disorders, as it is for Parkinson's disease, in both home and clinical environments [7–12].

Parkinson's disease (PD) can be characterized by motor deficiencies, such as bradykinesia and a combination of rest tremor, rigidity, as well as gait and balance impairment [13]. In routine clinical care, the evaluation of those deficiencies is mainly based on severity-rating standardized scales, such as the Movement Disorder Society Unified Parkinson's disease rating scale (MDS-UPDRS) [14], based on patients' reports and clinicians' vision-based evaluations, and clinical investigators determine the effectiveness of a therapy of a drug by using the MDS-UPDRS score [15]. Inconveniently, patient reports can be affected by mood and unfamiliarity with forms, and clinicians' evaluations can be