

1 Introduction

Parkinson's disease (PD) is a progressive neurological disorder with a growing worldwide prevalence¹ and associated rising health costs in the future². The disease is characterized mainly by four cardinal motor symptoms: resting tremor, bradykinesia, rigidity and postural instability.³ These symptoms often cause gait disturbances, such as reduced gait speed and shortened step length, leading to disability and reduced quality of life.^{4,5}

Within the past years treadmill training has become an important therapeutic tool in neurologic rehabilitation.^{6–12} People with PD significantly improved their gait speed, step length and walking distance after regular treadmill training.¹³ A few trials also investigated the acute adaptations in this population after a single treadmill session and showed improvements in gait speed, stride length and double stance phase.^{14–16}

While previous studies on treadmill training mainly varied walking speed^{15,17} and body-weight support^{14,18,19}, recent trials focused on explorative designs where participants are perturbed during treadmill walking. Such interventions included bilateral separated treadmill walking^{20,21} which manipulates participants' gait symmetry, perturbation of synchronized movements by applying specific forces to the lower limbs^{22,23}, visual-induced perturbations by manipulating the virtual environment^{24,25}, and treadmill training which provokes slips or trips of participants by sudden medio-lateral^{26–28} or anterior-posterior^{29–39} movements of the belt. Although these types of perturbations were very heterogeneous, all of them represented an additional postural challenge during treadmill walking.

Especially in PD, combining treadmill walking with balance training may enhance the beneficial effects of conventional treadmill training¹³, since studies have suggested that highly challenging balance exercises can counteract postural instability in PD⁴⁰. Thus a novel treadmill device (Zebris medical GmbH, H/P cosmos GmbH) was developed, with the purpose of applying additional perturbations during walking. To challenge participants' postural control, pneumatic actuators below the treadmill constantly induce small three-dimensional tilting movements. The primary purpose of this study was to examine acute adaptations in gait and postural control in individuals with PD after a single training session on the novel treadmill device. A secondary aim was to identify specific predictors which might explain differences in adaptations across participants.