Recovery performance and factors that classify young fallers and non-fallers in Parkinson's disease

María Moreno Catalá [a], Dirk Woitalla [b], Adamantios Arampatzis [a],*

[a] Department of Training and Movement Sciences, Humboldt-University Berlin, Philippstr. 13, 10115 Berlin, Germany
[b] Department of Neurology, St. Joseph Hospital, Ruhr-University, Gudrunstr. 56, 44791 Bochum, Germany

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ABSTRACT

Postural instability is a major problem for Parkinson's disease patients (PDs). Identifying the causes of postural instability at a young age would contribute to the development of adequate training interventions aiming to reduce falls. The purpose of this study was to investigate the effect of muscle strength and balance ability on dynamic stability control after simulated disturbances and to develop an applicable tool able to classify young PDs into fallers and non-fallers. Twenty-five young PDs (12 fallers, 13 non-fallers, 48 ± 5 yrs.) and 14 healthy controls participated in the study. Dynamic stability was examined during simulated forward falls. Muscle strength was assessed by isometric maximal plantarflexion and knee extension contractions. Balance ability was evaluated by measuring the anterior and posterior limits of stability (LoS). The fallers showed lower recovery performance in forward falls and lower muscle strength compared to controls. Muscle strength and anterior LoS were significantly associated to stability performance. These two factors could correctly classify 90% of PD fallers, establishing an accurate assessment tool to predict the falling risk in young PDs. Furthermore, muscle strength partly explained recovery performance; therefore, we can argue that young PDs with an increased falling risk may benefit from leg-extensors strengthening and stability training.

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* Corresponding author at: Humboldt-University Berlin, Department of Training and Movement Sciences, Philippstr. 13, Haus 11, 10115 Berlin, Germany. Tel.: +49 30 2093 46047.
E-mail addresses: maria.moreno.catala@hu-berlin.de (M. Moreno Catalá), dirk.woitalla@ruhr-uni-bochum.de (D. Woitalla), a.arampatzis@hu-berlin.de (A. Arampatzis).

1. Introduction

Postural instability is one of the primary symptoms in Parkinson's disease (PD). Episodes of falls are a direct consequence which has a dramatic impact on patient's mobility resulting in loss of independence and quality of life (Bloem, Grimbergen, Cramer, Willemsen, & Zwinderman, 2001). Several studies have analyzed the rate of falling in PD and have reported that up to 68% of patients experienced a fall in the last 12 months. However, posture and balance disorders are not taken into appropriate consideration and are sometimes even ignored at early stages of PD (Guler, Bir, Akdag, & Ardic, 2012).

Traditionally, the approach of the center of pressure (CoP) to the limits of stability (LoS) has been used to assess balance in healthy elderly as well as in elderly PD patients (Menant, St George, Fitzpatrick, & Lord, 2011; Shen & Mak, 2012). However, these tests show inconsistent results on fall prediction (Fasano, Plotnik, Bove, & Berardelli, 2012). For example, some studies found an association between the falling rate and functional reach distance or voluntary postural sway (Butler, Lord, & Fitzpatrick, 2011; Tucker, Kavanagh, Morrison, & Barrett, 2010), while others could not find any significant difference between fallers and non-fallers (Wallmann, 2001). Since most falls occur during dynamic situations (Rubenstein, 2006; Tinetti, Speechley, & Ginter, 1988), conclusions from investigations about static postural control are not directly transferable to dynamic stability control (Mackey & Robinovitch, 2005; Owings, Pavol, Foley, & Grabiner, 2000). Nevertheless, there might be a contribution of balance ability (i.e., the ability to approach the CoP to the LoS) to the increased risk of falling in PD patients, though this is still unclear.

Muscle strength of the leg extensors has been shown to significantly affect the recovery performance after sudden perturbations in elderly participants (Arampatzis, Karamanidis, & Mademli, 2008; Graham, Carty, Lloyd, Lichtwark, & Barrett, 2013; Karamanidis, Arampatzis, & Mademli, 2008). Postural corrections after a perturbation depend on the actions of both the support limb during the push-off phase and the recovery limb during the step execution phase (Karamanidis & Arampatzis, 2007; Pijnappels, Bobbert, & van Dieen, 2005a). Furthermore, it has been reported that deficits in using the mechanisms responsible for dynamic stability control affect balance recovery after simulated forward falls in elderly adults (Arampatzis et al., 2008).

There have been some attempts to analyze the impaired recovery performance responsible for the increased risk of falls in PD patients. During gait (Plotnik, Giladi, Dagan, & Hausdorff, 2011) and balance perturbation (Nanhoe-Mahabier et al., 2012) tasks, elderly PD patients have presented decreased gait bilateral coordination and greater displacement of the center of mass after perturbations, respectively. Diminished ability to optimize postural response for changes in postural demand has been also reported in PD patients (Dimitrova, Horak, & Nutt, 2004; Horak, Dimitrova, & Nutt, 2005). Summarizing, a lot of studies in the past have investigated the specific risk factors for falls in PD in a retrospective (Ashburn, Stack, Pickering, & Ward, 2001a; Durmus et al., 2010; Robinson et al., 2005) as well as in a prospective way (Allen, Canning, Sherrington, et al., 2010; Bloem et al., 2001; Kerr et al., 2010; Latt, Lord, Morris, & Fung, 2009; Paul et al., 2014; Pickering, Grimbergen, Rigney, et al., 2007). These studies have highlighted impaired balance, freezing of gait, decreased muscle strength, impaired cognition and disease severity as important factors associated to the higher falling rate in PD. However, all these studies were conducted with elderly patients and their results may not be directly applicable to young PD patients. Since the mean age of disease onset is around 65 years old, it is very difficult to differentiate between the factors intrinsic to the disease and the factors resulting from natural age-related degeneration. New knowledge gained in elderly PD patients is not directly transferable to young PD patients, since it is well known that the ability to control stability deteriorates in healthy elderly, as compared to healthy young adults (Karamanidis & Arampatzis, 2007; Pijnappels, Bobbert, & van Dieen, 2005b; Wojcik, Thelen, Schultz, Ashton-Miller, & Alexander, 1999).

Early or young onset PD is defined as Parkinson's disease diagnosed before the age of 51 years (Marder et al., 2010; Schrag & Schott, 2006). Although early onset PD patients seem to experience motor symptoms similar to normal or late onset patients (Calne & Kumar, 2008), they are characterized by earlier and more frequent motor fluctuations and treatment-related dyskinesia than normal onset patients (Lucking et al., 2000; Quinn, Critchley, & Marsden, 1987; Schrag, Hovris, Morley, Quinn, & Jahanshahi, 2003). Both motor fluctuations and dyskinesia are very incapacitating factors