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Classification of gait disturbances: distinguishing between continuous and episodic changes

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Abstract

The increased awareness of the importance of gait and postural control to quality of life and functional independence has led many research groups to study the patho-physiology, epidemiology, clinical, and therapeutic aspects of these motor functions. In recognition of the increased awareness of the significance of this topic, the *Movement Disorders* Journal is devoting this entire issue to gait and postural control. Leading research groups provide critical reviews of the current knowledge and propose future directions for this evolving field. The results of a large randomized controlled trial designed to reduce falls and improve mobility in people with Parkinson's disease is also included in this issue.

The intensive work in this area throughout the world has created an urgent need for a unified language. Because gait and postural disturbances are so common, the clinical classification should be clear, straightforward and simple to use. As an introduction to this special issue, we propose a new clinically based classification scheme that is organized according to the dominant observed disturbance, while taking into an account the results of a basic neurological exam. The proposed classification differentiates between continuous and episodic gait disturbances since this subdivision has important ramifications from the functional, prognostic and mechanistic perspectives.

We anticipate that research into gait and postural control will continue to flourish over the next decade as the search for new ways of promoting mobility and independence aims to keep up with the exponentially growing population of aging older adults. Hopefully, this new classification scheme and the papers focusing on gait and postural control in this special issue of the *Movement Disorders* Journal will help to facilitate future investigations in this exciting and rapidly growing area.

Keywords

balance; gait; classification; falls; Parkinson's disease

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INTRODUCTION

The ability to walk safely, effectively and efficiently is essential for an independent and productive life. Gait and postural control predict quality of life, morbidity and mortality[1-11]. The fear of losing the ability to walk or even to stand or sit in an upright position is frequently the first and most significant concern that is raised when a person is diagnosed with stroke, Parkinson's disease, ataxia or other movement disorders. It is not surprising that people make great efforts to maintain independent walking. Many studies have shown the significant role of mobility and safe walking in the quality of life of patients and older adults[12-16]. Recently, a large systematic review reported that walking safely is the most significant motor symptom in the quality of life among patients with Parkinson's disease[17].

The increased awareness of the importance of gait and postural control in quality of life and functional independence has led many research groups around the globe to focus their research programs on the pathophysiology, epidemiology, clinical, and therapeutic aspects of walking and balance[18]. As part of the increased awareness of the significance of this topic, the *Movement Disorders* Journal is devoting this entire issue to gait and postural control. Here, leading research groups provide critical reviews of the current knowledge on specific aspects of gait and posture and propose future directions for translating this evolving research field into clinical implementation.

OVERVIEW OF THE SPECIAL ISSUE

Recent work has shown that the locomotion and posture control networks use very large parts of the central and peripheral nervous systems[19-24]. Similarly, gait and balance are no longer perceived as purely motor tasks or reflexes but are viewed as complex, sensorimotor behaviors, heavily affected by cognitive and affective aspects[3;8;22;25-32]. This may partially explain the sensitivity to subtle neuronal dysfunction, and why abnormal gait or postural control can predict the development of dementia or parkinsonism years before they are diagnosed clinically[2;4;33-36]. These ideas will be highlighted throughout this special issue of the *Movement Disorders* Journal. These fundamental concepts will also be discussed with respect to emerging therapeutic approaches that combine physical, technological and cognitive interventions, along with traditional physical and occupational therapy for improving gait and mobility[37-41].

Another recent development in gait and posture research is the ability to quantify and characterize the overall locomotor pattern, individual steps, and postural sway during stance in the gait lab or at home using body-fixed sensors, i.e., small lightweight devices that can be worn by the subject[42-47]. The combination of very detailed assessment of discrete steps or postural responses with a less detailed, but longer monitoring of mobility and stability in real-life, has the potential to significantly enhance our understanding of mobility behavior and episodic gait disturbances[31;48-50]. Objective measures of balance and gait promise to lead to the development of a personalized approach to the evaluation and treatment of each subject's gait or posture disturbances. Home-based monitoring and online, real-time notification of episodic events, such as falls, is at the forefront of gait research, along with new modes of intervention modalities that will hopefully make their way into the clinic in the near future. The significant progress in gait and posture assessment and long-term monitoring has started to influence the entire field and the current understanding and potential interventions discussed in this special issue of the *Movement Disorders* Journal reflect this general progress.

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A NEW CLINICAL CLASSIFICATION SCHEME

The intensive work in gait and posture research throughout the world has created an urgent need for a unified language. Over the past 20 years, several groups have proposed classifications of gait and posture disturbances, focusing on the neurological systems, the anatomical source of dysfunction, or the clinical features[18;51-56]. Because gait and postural disturbances are so common and their assessment is part of the basic physical and neurological exam, the clinical classification should be clear, straightforward and simple to use. As an introduction to this exciting special issue of the *Movement Disorders Journal* on gait and posture, we propose a new clinical classification scheme which is clinically based according to the dominant observed disturbance, while taking into an account the results of a basic neurological exam.

The proposed classification differentiates between continuous and episodic gait disturbances because we believe that this subdivision has important ramifications from the functional, prognostic and mechanistic perspectives. Continuous gait disturbances may be the result of chronic neuronal or peripheral dysfunction. Typically, the patient will adapt to abnormal, but predictable, impairments and will learn to adjust and compensate with changes in motor behavior. Evaluation of gait and balance in patients with continuous disturbances reflects the underlying pathology as well as any compensatory mechanisms. Walking aids are one obvious form of compensation that may help to improve continuous gait disturbances. However, cognitive resources may also be called in to play, either consciously or sub-consciously, to ameliorate the underlying pathology. The role of all compensatory factors should be assessed.

In the past, episodic gait disturbances have received less attention. In contrast to the continuous gait disturbances, episodic disturbances are, by definition, unpredictable. The patient is not able to adapt to these transient changes and as a result, these gait disturbances are often the primary cause of falls, anxiety, fear, and avoidance behavior[57-60]. Treatment may focus on the underlying pathology, decreasing the provocative factors, and strategies to avoid or overcome the event. However, optimal therapies are still not available for most episodic gait disturbances.

Gait classification is relatively straightforward when the peripheral nervous system or the musculo-skeletal changes play a major role in the clinical picture. When abnormal gait is the result of isolated spinal cord, cortico-spinal tract, cerebellum or extra-pyramidal system dysfunction, it is still relatively easy to characterize. These could be referred to as “pure” disturbances. Characterization of gait problems becomes a real challenge when only subtle changes in multiple neural systems are the underlying pathophysiology; sometimes this could be referred to as a form of mixed or multi-factorial disturbance. The task becomes extremely difficult when cognitive and affective changes exacerbate the complex picture. In those instances, one cannot refer to specific neuronal system and the gait features are highly variable and do not follow a specific pattern. Previous classifications[61], including ours[62], have referred to these bizarre gaits as “High Level Gait Disorders”, “Frontal Gait Disorders” or “Subcortical Gait Disturbances” (See Nutt for further discussion on this issue[63]). In these patients, one can easily diagnose an abnormal gait but it is usually impossible to distinguish between the specific contributions of different sensory, motor or mental modalities. Increased fear, imbalance, muscle weakness, loss of basic locomotion rhythmicity and cognitive disturbances in the form of dys-executive syndrome all may contribute to the clinical picture[5;64;65]. Abnormal motor planning and execution, disturbed negotiation with obstacles or the environment in general, increased gait and postural disturbances while dual-tasking or misjudgment of hazard risks or personal abilities can further increase the diagnostic challenge. In contrast to the more simple pure and mixed types, perhaps it may be

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helpful to consider that these gait disturbances involve problems of integration among multiple systems.

Before concluding, it is important to take note of a caveat when distinguishing between the continuous and episodic gait disturbances. Freezing of gait is a prime example of an episodic gait disturbance. Freezing is unpredictable, transient, and does not take place continuously. At the same time, however, patients with Parkinson’s disease who suffer from freezing may also suffer from more exaggerated continuous gait disturbances, compared to those patients who are less likely to have freezing[66-69]. In some sense, episodic gait disturbances like freezing of gait may be the unsafe combination of a transient event operating on the background of continuous changes that, unfortunately, help to set the stage for these episodic disturbances. In other words, the underlying risk that an episodic gait disturbance might occur may be related to continuous and transient changes that may also be occurring simultaneously in a given patient. A simple dichotomy between the continuous and episodic gait disturbances may sometimes belie a more complex and nuanced picture. Similar to the way that the continuous gait alterations can be isolated or several can take place simultaneously in a more mixed state (e.g., spasticity and bradykinesia; spasticity and weakness), so too the same patient may suffer from both episodic and continuous gait disturbances. Since many of the gait disturbances may co-exist, determination of a multidimensional profile may help to inform the clinical diagnosis.

To conclude, we suggest that differentiating gait disturbances based on the proposed classification will improve future communication when clinically characterizing a patient’s gait for teaching or research purposes. We anticipate that research into gait and postural control will continue to flourish over the next decade as the search for new ways of promoting the maintenance of mobility and independence try to keep up with the exponentially growing population of older adults who are prone to gait disturbances. Hopefully, this new classification scheme and the papers focusing on gait and postural control in this special issue of *Movement Disorders* will help to facilitate future investigations in this exciting and rapidly growing area.

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Table 1

Classification of gait disturbances by clinical presentation*

Continuous – Occurs consistently with locomotion (can vary in severity)
Ataxic – disequilibrium and hypermetria of stance and gait
Somatosensory
Vestibular
Cerebellar
Spastic – associated with increased postural tone
Hemiparetic
Paraparetic / Tetraparetic
Bradykinetic / hypokinetic – slow or small steps and/or slow or small postural responses
Dyskinetic/Choreic/Dystonic – involuntary movements
Paretic – associated with muscle weakness or paralysis
Trunkal – static, axial postural deformities
Antalgic – secondary to musculo-skeletal or central pain
Higher Level (Frontal)
"Apractic"
Anxious, fear of falling, cautious
Bizarre
Severely depressed
Psychogenic
Undetermined – sometimes it may be difficult to classify the continuous nature of the gait disturbance.
Episodic – occurs intermittently during locomotion (may vary in severity and frequency)
Freezing – transient inability to create effective stepping
Festination – unintentional increase in speed, usually with small steps
Disequilibrium – transient loss of balance
Mixed types - where a person suffers from more than one continuous disturbance, or continuous and episodic disturbances, for example, are possible.

*classification should be performed after completion of a general and neurological exam.