

the affected hand and arm. On cortical sensory testing (e.g., two-point discrimination, graphesthesia), abnormalities are often found but primary sensation is usually intact. Anterior parietal infarction may present as a pseudothalamic syndrome with contralateral loss of primary sensation from head to toe. Dysesthesias or a sense of numbness and, rarely, a painful state may also occur.

Focal Sensory Seizures These seizures generally are due to lesions in the area of the postcentral or precentral gyrus. The principal symptom of focal sensory seizures is tingling, but additional, more complex sensations may occur, such as a rushing feeling, a sense of warmth, or a sense of movement without detectable motion. Symptoms typically are unilateral; commonly begin in the arm or hand, face, or foot; and often spread in a manner that reflects the cortical representation of different bodily parts, as in a Jacksonian march. Their duration is variable; seizures may be transient, lasting only for seconds, or persist for an hour or more. Focal motor features may supervene, often becoming generalized with loss of consciousness and tonic-clonic jerking.

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32

Gait and Balance Disorders

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PREVALENCE, MORBIDITY, AND MORTALITY

Gait and balance problems are common in the elderly and contribute to the risk of falls and injury. Gait disorders have been described in 15% of individuals older than 65. By age 80 one person in four will use a mechanical aid to assist with ambulation. Among those 85 and older, the prevalence of gait abnormality approaches 40%. In epidemiologic studies, gait disorders are consistently identified as a major risk factor for falls and injury.

A substantial number of older persons report insecure balance and experience falls and fear of falling. Prospective studies indicate that 30% of those older than 65 fall each year. The proportion is even higher in frail elderly and nursing home patients. Each year, 8% of individuals older than 75 suffer a serious fall-related injury. Hip fractures result in hospitalization, can lead to nursing home admission, and are associated with an increased mortality risk in the subsequent year. For each person who is physically disabled, there are others whose functional independence is limited by anxiety and fear of falling. Nearly one in five elderly individuals voluntarily restricts his or her activity because of fear of falling. With loss of ambulation, the quality of life diminishes, and rates of morbidity and mortality increase.

ANATOMY AND PHYSIOLOGY

An upright bipedal gait depends on the successful integration of postural control and locomotion. These functions are widely distributed in the central nervous system. The biomechanics of bipedal walking are complex, and the performance is easily compromised by a neurologic deficit at any level. Command and control centers in the brainstem, cerebellum, and forebrain modify the action of spinal pattern generators to promote stepping. While a form of “fictive locomotion” can be elicited from quadrupedal animals after spinal transection, this capacity is limited in primates. Step generation in primates is dependent on locomotor centers in the pontine tegmentum, midbrain, and subthalamic region. Locomotor synergies are executed through the reticular formation and descending pathways in the ventromedial spinal cord. Cerebral control provides a goal and purpose for walking

and is involved in avoidance of obstacles and adaptation of locomotor programs to context and terrain.

Postural control requires the maintenance of the center of mass over the base of support through the gait cycle. Unconscious postural adjustments maintain standing balance: long latency responses are measurable in the leg muscles, beginning 110 milliseconds after a perturbation. Forward motion of the center of mass provides propulsive force for stepping, but failure to maintain the center of mass within stability limits results in falls. The anatomic substrate for dynamic balance has not been well defined, but the vestibular nucleus and midline cerebellum contribute to balance control in animals. Patients with damage to these structures have impaired balance while standing and walking.

Standing balance depends on good-quality sensory information about the position of the body center with respect to the environment, support surface, and gravitational forces. Sensory information for postural control is primarily generated by the visual system, the vestibular system, and proprioceptive receptors in the muscle spindles and joints. A healthy redundancy of sensory afferent information is generally available, but loss of two of the three pathways is sufficient to compromise standing balance. Balance disorders in older individuals sometimes result from multiple insults in the peripheral sensory systems (e.g., visual loss, vestibular deficit, peripheral neuropathy) that critically degrade the quality of afferent information needed for balance stability.

Older patients with cognitive impairment from neurodegenerative diseases appear to be particularly prone to falls and injury. There is a growing body of literature on the use of attentional resources to manage gait and balance. Walking is generally considered to be unconscious and automatic, but the ability to walk while attending to a cognitive task (*dual-task walking*) may be compromised in frail elderly individuals with a history of falls. Older patients with deficits in executive function may have particular difficulty in managing the attentional resources needed for dynamic balance when distracted.

DISORDERS OF GAIT

Disorders of gait may be attributed to frailty, fatigue, arthritis, and orthopedic deformity, but neurologic causes are disabling and important to address. The heterogeneity of gait disorders observed in clinical practice reflects the large network of neural systems involved in the task. Walking is vulnerable to neurologic disease at every level. Gait disorders have been classified descriptively on the basis of abnormal physiology and biomechanics. One problem with this approach is that many failing gaits look fundamentally similar. This overlap reflects common patterns of adaptation to threatened balance stability and declining performance. *The gait disorder observed clinically must be viewed as the product of a neurologic deficit and a functional adaptation.* Unique features of the failing gait are often overwhelmed by the adaptive response. Some common patterns of abnormal gait are summarized next. Gait disorders can also be classified by etiology (Table 32-1).

TABLE 32-1 ETIOLOGY OF GAIT DISORDERS

Etiology	No. of Cases	Percent
Sensory deficits	22	18.3
Myelopathy	20	16.7
Multiple infarcts	18	15.0
Parkinsonism	14	11.7
Cerebellar degeneration	8	6.7
Hydrocephalus	8	6.7
Toxic/metabolic causes	3	2.5
Psychogenic causes	4	3.3
Other	6	5.0
Unknown causes	17	14.2
Total	120	100

Source: Reproduced with permission from J Masdeu, L Sudarsky, L Wolfson: *Gait Disorders of Aging*. Lippincott Raven, 1997.