

Pathophysiology of Spasticity

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Following central motor lesions, two forms of adaption can be observed which lead to improved mobility: (1) the development of spastic muscle tone (for review see Dietz 2002), and (2) the activation of spinal locomotor centers induced by specific treadmill training (Dietz et al.1994; for review see Dietz and Harkema 2004). Tension development during spastic gait is different from that during normal gait and appears to be independent of exaggerated monosynaptic stretch reflexes. Exaggerated stretch reflexes are associated with an absence or reduction of functionally essential polysynaptic reflexes. When supraspinal control of spinal reflexes is impaired, the inhibition of monosynaptic reflexes is missing in addition to a reduced facilitation of polysynaptic reflexes. Therefore, overall leg muscle activity becomes reduced and less well modulated in patients with spasticity. Electrophysiological and histological studies have shown that a transformation of motor units takes place following central motor lesions with the consequence that regulation of muscle tone is achieved at a lower level of neuronal organization which in turn enables the patient to walk. Based on observations of the locomotor capacity of the spinal cat, recent studies have indicated, that spinal locomotor centers can be activated and trained in patients with complete or incomplete paraplegia when the body is partially unloaded. However, the level of electromyographic activity in the gastrocnemius (the main antigravity muscle during gait) is considerably lower in the patients compared to healthy subjects. During the course of a daily locomotor training program, the amplitude of gastrocnemius, electromyographic activity increases significantly during the stance phase, while inappropriate tibialis anterior activation decreases. Patients with incomplete paraplegia benefit from such training programs such that their walking ability on a stationary surface improves. The pathophysiology and functional significance of spastic muscle tone and the effects of treadmill training on the locomotor pattern underlying new attempts to improve the mobility of patients with a central motor lesion are reviewed.

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