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The Modulation of Presynaptic Inhibition in Single Muscle Primary Afferents during Fictive Locomotion in the Cat

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The aim of this study is to understand the functional organization of presynaptic inhibition in muscle primary afferents during locomotion. Primary afferent depolarization (PAD) associated with presynaptic inhibition was recorded intra-axonally in identified afferents from various hindlimb muscles in L6–L7 spinal segments during fictive locomotion in the decerebrate cat. PADs were evoked by the stimulation of peripheral muscle nerves and were averaged in the different epochs of the fictive step cycle. Fifty-three trials recorded from 39 muscle axons (37 from group I and two from group II) were retained for analysis. The results showed that there was a significant phase-dependent modulation of PAD amplitude ($p < 0.05$) in a majority of muscle afferents (30 of 39, 77%). However, not all stimulated nerves led to significantly modulated PADs in a given axon (36 of 53 trials, 68%). We also observed that the pattern of modulation (phase for maximum and minimum PAD amplitude and the depth of modulation) varied with each recorded afferent, as well as with each stimulated nerve. We further evaluated the effect of PAD modulation on the phasic transmission of the monosynaptic reflex (MSR) and found that PADs decreased the MSR amplitude in all phases of the fictive step cycle, independent of the PAD pattern in individual group I fibers. We conclude that (1) PAD modulation patterns of all group I fibers contacting motoneurons led to an overall reduction in monosynaptic transmission, and (2) individual PAD patterns could participate in the control of transmission in specific reflex pathways during locomotion.

Key words: primary afferent depolarization (PAD); presynaptic inhibition; muscle group I fibers; fictive locomotion; spinal cord; motor control

Although the central pattern generator (CPG) (Grillner, 1981) in mammalian spinal cord is able to produce complex locomotor patterns in the absence of sensory input, sensory feedback in general, and proprioceptive input in particular, is needed for adaptive modifications of the step cycle (Rossignol, 1996). For instance, proprioceptive input from muscles is used to adjust the timing and amplitude of muscle contractions during the different phases of the step cycle (Pearson and Duysens, 1976; Conway et al., 1987; Gossard et al., 1994a; McCrea et al., 1995; Hiebert et al., 1996). To be meaningful, the efficacy of proprioceptive feedback must be phasically controlled to induce adaptive responses in the proper phase of the locomotor cycle. Peripheral (e.g., gamma innervation of muscle spindles), as well as central, mechanisms participate in the phasic modulation of transmission in proprioceptive pathways.

One powerful central mechanism by which the CPG could control sensory feedback is presynaptic inhibition of primary afferent terminals. Indeed, there are GABAergic interneuronal networks in the spinal cord capable of decreasing transmitter release by evoking a primary afferent depolarization (PAD) through axoaxonic contacts (Eccles, 1961; Schmidt, 1971; Nicoll and Alger, 1979). Presynaptic inhibition has been proposed often to explain changes in the amplitude of the monosynaptic reflex (MSR) during walking in humans (Stein and Capaday, 1988; Yang and Whelan, 1993). Moreover, when PADs reach firing threshold, the evoked discharges are antidromically propagated in primary afferent axons and may collide with incoming volleys and even change the excitability of peripheral sensory receptors (Tonnies, 1939; Lindblom, 1958; Loewenstein, 1959, Ito, 1968; Bévengut et al., 1997). For example, rhythmic bursts of antidromic discharges can be found in a majority of cut dorsal rootlets of decerebrated cats walking on a treadmill (Beloozerova and Rossignol, 1994, 1995). The phasic timing of such discharges suggests that the underlying PADs are strongly influenced by the CPG. It is thus important to know more about the role of PAD pathways in the control of locomotion. There are, however, few studies focused on the transmission in PAD pathways during locomotion in mammals. Duenas et al. (1990) evoked antidromic discharges in dorsal rootlets belonging to the triceps surae muscles by stimulating cutaneous nerves during stepping in thalamic cats and found that maximal discharges occurred during the extensor phase of the step cycle. Similarly, previous intracellular studies of PADs in cutaneous afferents during fictive locomotion showed that the amplitude of the evoked PAD was maximal during the extensor phase (Gossard and Rossignol, 1990; Gossard et al., 1990). To our knowledge, there is yet no study investigating directly the changes in PAD amplitude in individual muscle afferents during locomotion. We thus used intra-axonal recordings to study PADs in single primary afferents from hindlimb muscles of the decerebrate cat during fictive locomotion. We also evaluated directly, and for the first time, the effect of PADs on the MSR amplitude during fictive locomotion.

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The XII ISEK Congress is also held in Montreal, at the Queen Elizabeth Hotel, this Universite de Montreal, C.P. , Succursale Centre-Ville, Montreal, .. Effects of 4-aminopyridine on Motor Evoked Potentials and EMG Interference Patterns in Proceedings of the 17th Annual International Conference of the IEEE.Departements de physiologie et de pathologie et Centre de recherche en sciences . further subdivided in two, one focussing on the GABA neurons and.the Centre de recherche en sciences neuro%ogiqanes, Universitd de. MontrCal, called Chronic Musculoskeletal Pain, held in Montreal,. QuC., May 24 , . Sutton and Belar), neck (Martin and Mathews), or .. (4 Chronic lower back pain for there .. excitability of a group of neurons with high-threshold inputs.Department of Physiology and Pharmacology, University of Southampton, . Symposium on "Excitotoxins" held at the Wenner-Gren Center in Stockholm on August 26 increase in neuronal excitability is indicated by the lack of effect of kainate en Sciences Neurologiques, Facultede Medicine, Universite de Montreal.65, , Dr. Chauncey D. Leake and the University of Texas Medical Branch, .. Breast disease: proceedings of an international symposium, May 17, of a conference held at the Institute of Psychiatry, London, 9 to 11 May ; of the Centre de recherche en sciences neurologiques of the Universite de.Medicine (WASM) may be found at wsdmind.comg and .. Sunday 4th February , in Vibhavadee Ballroom on .. New Special Course: The Basic Science of Sleep and Dreaming .. the Dental-Medical School of the Universite de Montreal Montreal, Neurologique, Lyon, France.membrane excitability changes that may be a function of the connectivity University of Basel Library, on 11 Jul at , subject to the .. neuronal systems (center) that mediate REM sleep electro- Centre de Recherche en Sciences Neurologiques, Facult6 de M6decine, In: Neuroscicnce symposia, vol. 3.Chairman, Department of Neurology and Neurological Sciences, Stanford Univ. School of Medicine Servier Lecturer, University of Montreal (). The Larry.