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SPINAL NEURONS BURSTING IN PHASE WITH FICTIVE SCRATCHING ARE NOT RELATED TO SPONTANEOUS CORD DORSUM POTENTIALS

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Abstract—Spontaneous cord dorsum potentials (spontaneous CDPs) are produced by the activation of dorsal horn neurons distributed along the L4 to S1 spinal cord segments, in Rexed's laminae III–VI, in the same region in which there are interneurons rhythmically bursting during fictive scratching in cats. An interesting observation is that spontaneous CDPs are not rhythmically superimposed on the sinusoidal CDPs generated during fictive scratching episodes, thus suggesting that the interneurons producing both types of CDPs belong to different spinal circuits. In order to provide experimental data to support this hypothesis, we recorded unitary activity of neurons in the L6 spinal cord segment. We found that the neurons firing rhythmically during the sinusoidal CDPs associated with the extensor, flexor or intermediate phases of scratching were not synchronized with the spontaneous CDPs. Moreover, we found that the neurons firing during the spontaneous CDPs were not synchronized with the sinusoidal CDPs. These results suggest that the neurons involved in the occurrence of spontaneous CDPs are not part of the spinal cord central pattern generators (CPGs). This study will be relevant for understanding the relationships between the spinal cord neuronal populations firing spontaneously and the CPGs, in the intact and injured spinal cord.

Key words: CDP, spontaneous, CPG, central pattern generator, dorsal horn neurons, scratching.

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Abbreviations: AC, alternating current; CI, confidence interval; CPGs, central pattern generators; CUSUM, cumulative sum; DC, direct current; ENG, electroneurographic; LGS, lateral gastrocnemius plus soleus; MG, medial gastrocnemius; nCDPs, negative cord dorsum potentials; npCDPs, negative–positive cord dorsum potentials; PSTHs, peri-stimulus time histograms; sinusoidal CDPs, sinusoidal cord dorsum potentials; spontaneous CDPs, spontaneous cord dorsum potentials; TA, tibialis anterior.

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INTRODUCTION

Neuronal ensembles in the spinal cord accomplish many physiological roles. The study of the interaction between these neuronal networks allows an integral understanding of the complexity of diverse processes, such as during the generation of stereotyped movements and their modulation by other neighboring neuronal groups. One of these populations of neurons is associated with the spontaneous electrical potentials recorded in the dorsum of the lumbar and sacral spinal cord segments (spontaneous cord dorsum potentials (CDPs); Bremer, 1941; Ten Cate, 1950; Mark and Gasteiger, 1953). Large-amplitude spontaneous CDPs are generated by the synchronous activation of a population of dorsal horn neurons (Rexed's laminae III–VI) that respond monosynaptically to low-threshold cutaneous afferents (Manjarrez et al., 2000). In the anaesthetized cat, Manjarrez et al. (2003) reported that the spontaneous CDPs, lasting 40–60 ms, have characteristically low-frequency components (3–20 Hz) and suggested that such potentials are longitudinally synchronized throughout several lumbosacral spinal segments (see also Manjarrez et al., 2002a,b,c, 2005). Moreover, García et al. (2004) showed that the synchronization between the spontaneous CDPs recorded from neighboring segments was reduced after interposed spinal lesions. Recently, Chávez et al. (2012) reported the occurrence of spontaneous negative cord dorsum potentials (nCDPs) and negative–positive cord dorsum potentials (npCDPs) and analyzed the correlation of both potentials between the L5–L7 spinal segments in the anaesthetized cat. According to this study, under conditions of low synchronization, a set of neurons would generate the spontaneous CDPs and activate the class I interneurons mediating the non-reciprocal Ib inhibition. Otherwise, increased synchronization of the spontaneous activity would produce the spontaneous npCDPs by recruiting an additional set of interneurons which are included in the neuronal pathways producing PAD of cutaneous afferents in the dorsal horn and of muscle afferents, possibly via class II interneurons in the intermediate zone (see Rudomin et al., 1987; Rudomin, 1990). However, although these studies suggest the concomitant participation of cutaneous and Ib neurons during the generation of spontaneous CDPs, it is important to consider recent studies that indicate that