World Academy of Science, Engineering and Technology
International Journal of Bioengineering and Life Sciences
Vol:10, No:02, 2016

Signal Transduction in a Myenteric Ganglion

Authors : I. M. Salama, R. N. Miftahof

Abstract : A functional element of the myenteric nervous plexus is a morphologically distinct ganglion. Composed of sensory, inter- and motor neurons and arranged via synapses in neuronal circuits, their task is to decipher and integrate spike coded information within the plexus into regulatory output signals. The stability of signal processing in response to a wide range of internal/external perturbations depends on the plasticity of individual neurons. Any aberrations in this inherent property may lead to instability with the development of a dynamics chaos and can be manifested as pathological conditions, such as intestinal dysrhythmia, irritable bowel syndrome. The aim of this study is to investigate patterns of signal transduction within a two-neuronal chain - a ganglion - under normal physiological and structurally altered states. The ganglion contains the primary sensory (AH-type) and motor (S-type) neurons linked through a cholinergic dendro somatic synapse. The neurons have distinguished electrophysiological characteristics including levels of the resting and threshold membrane potentials and spiking activity. These are results of ionic channel dynamics namely: Na+, K+, Ca++- activated K+, Ca++ and Cl-. Mechanical stretches of various intensities and frequencies are applied at the receptive field of the AH-neuron generate a cascade of electrochemical events along the chain. At low frequencies, $\nu < 0.3$ Hz, neurons demonstrate strong connectivity and coherent firing. The AH-neuron shows phasic bursting with spike frequency adaptation while the S-neuron responds with tonic bursts. At high frequency, $\nu > 0.5$ Hz, the pattern of electrical activity changes to rebound and mixed mode bursting, respectively, indicating ganglionic loss of plasticity and adaptability. A simultaneous increase in neuronal conductivity for Na+, K+ and Ca++ ions results in tonic mixed spiking of the sensory neuron and class 2 excitability of the motor neuron. Although the signal transduction along the chain remains stable the synchrony in firing pattern is not maintained and the number of discharges of the S-type neuron is significantly reduced. A concomitant increase in Ca++- activated K+ and a decrease in K+ in conductivities re-establishes weak connectivity between the two neurons and converts their firing pattern to a bistable mode. It is thus demonstrated that neuronal plasticity and adaptability have a stabilizing effect on the dynamics of signal processing in the ganglion. Functional modulations of neuronal ion channel permeability, achieved in vivo and in vitro pharmacologically, can improve connectivity between neurons. These findings are consistent with experimental electrophysiological recordings from myenteric ganglia in intestinal dysrhythmia and suggest possible pathophysiological mechanisms.

Keywords : neuronal chain, signal transduction, plasticity, stability
Conference Title : ICCB 2016 : International Conference on Computational Biology
Conference Location : Paris, France
Conference Dates : February 22-23, 2016