

POSTER PRESENTATION

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Axon initial segment potassium channel density in cortical neurons

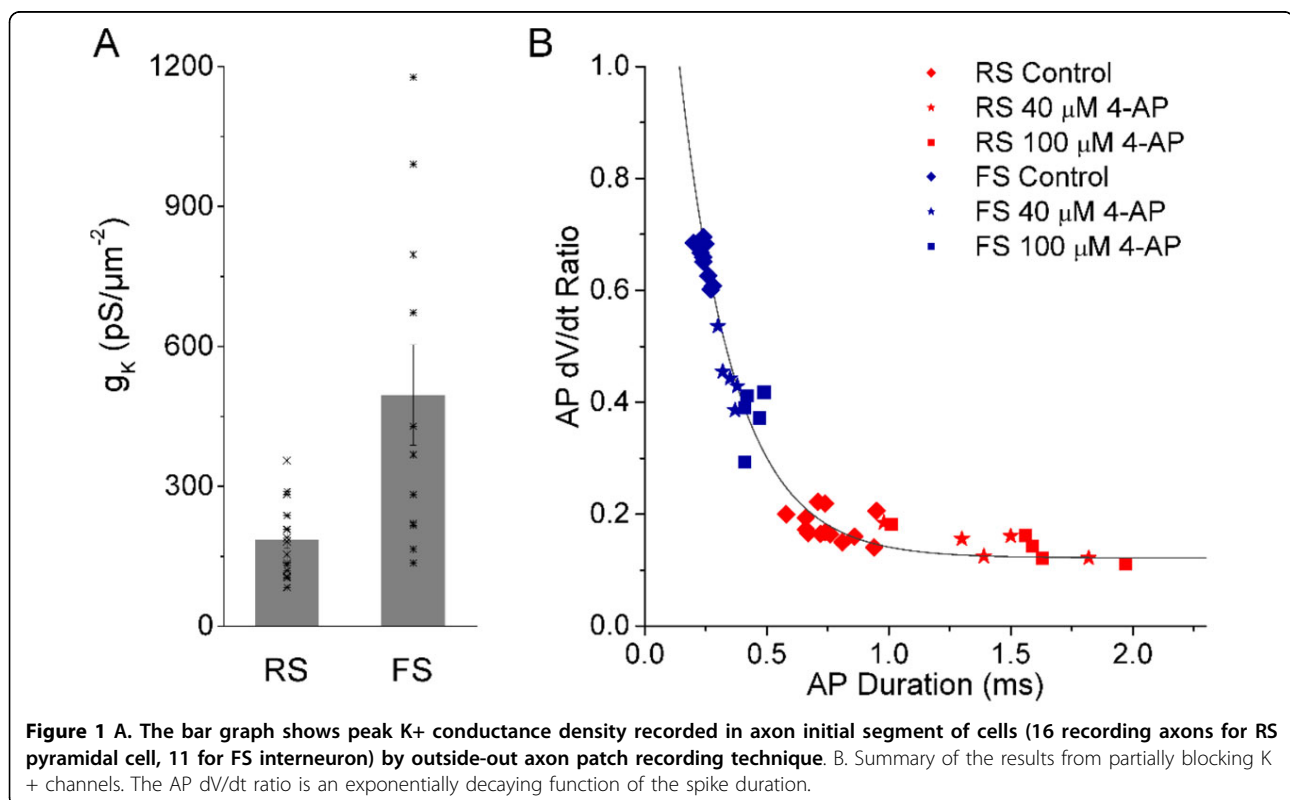
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There is a growing interest in estimating actual density ranges of Na⁺ channels in the very thin axon, especially in the action potential (AP) initiation zone, i.e., the axon initial segment (AIS, 20-50 microns away from the cell body). Both immunostaining studies and patch-clamp recordings indicated a relatively high density of Na⁺ channels in AIS of either pyramidal regular-spiking (RS) cells

[1] or fast-spiking (FS) GABAergic interneurons [2,3]. Here, we investigated potassium channel densities in AISs of both RS and FS cells in same recording conditions.

Our axonal recordings directly revealed that there is a very lower potassium density $g_K = 185.8 \pm 19$ pS/ μm^2 ($N = 16$) for the RS AIS while a higher g_K (495.7 ± 108 pS/ μm^2 , $N = 11$) for FS AIS, see Figure 1A. For both the



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RS pyramidal cells and FS PV cells, partially blocking K⁺ channels by applying 4-AP broadened the spike duration and decreased the dV/dt ratio significantly ($P < 0.05$) (For RS cells: $N = 5$; For FS cells: $N = 4$). Interestingly, we observed that the AP dV/dt ratio is an exponentially decaying function of the spike duration for both RS- and FS-spikings (see Figure 1B), such that $y = 0.12 + 0.16 \exp((0.5-x)/0.2)$, where y represents the dV/dt ratio and x represents the AP duration. These observations suggest strongly that potassium channel density is one of the major intrinsic factors dominating the spike shape properties, especially half-height spike duration and dV/dt ratio.

In sum, the significant difference in potassium channel density in axonal initial segment where action potentials are initiated may play a critical role in controlling action potential properties of both RS- and FS-spiking cells in nervous system by the same general biophysical rule. These results may be important for constructing computational models of different types of cortical neurons.

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