Abstract

The postsynaptic modulation of somatostatin (SST) on substantia gelatinosa (SG) neuron during the nociceptive information processing in the spinal cord is still obscure. In this study, membrane properties of SG neuron and SST effects on them were studied in the slices of juvenile rat lumbar spinal cords. Membrane potentials and conductances in visually identified SG neurons were recorded using the whole-cell patch clamp technique. Bath application of SST-14 caused a prominent and repeatable hyperpolarization (8.7±0.8 mV, n=17) with decrease in neuronal input resistance. In voltage-clamp study, current-voltage relationship from -120 to -40 mV revealed three type of non-inactivating membrane currents: $I_{\text{leak}}$, $I_{K_{\text{ir}}}$ and $I_{h}$. From holding potential of -60 mV, $I_{K_{\text{ir}}}$ developed instantaneously upon hyperpolarization of membrane potential and did not show any time-dependent inactivation. Extracellularly applied Ba$^{2+}$ ion inhibited $I_{K_{\text{ir}}}$ dose-dependently with ED$_{50}$ of 8.6 M. Application of SST produced an increase in membrane conductance in dose-dependent manner, with an ED$_{50}$ of 113 nM. The SST-induced current also developed almost instantaneously and did not show any time-dependent inactivation. The current-voltage
relationship exhibited inward rectification. The conductance of SST-induced current increased in high concentration of external K$^+$ ion. The reversal potentials in different external K$^+$ ion concentrations were close to the K$^+$ ion equilibrium potential. While blocking the SST-induced currents with low concentration of extracellular Ba$^{2+}$ ion, $I_{\text{leak}}$ or $I_h$ were not affected by SST. In addition, in neurons recorded with internal solution containing GTP$\gamma$S (0.1 mM), SST induced outward current and hyperpolarization which did not reverse on washing. In many neurons with GTP$\gamma$S in the pipette, a current was induced in the absence of SST that has properties identical to those of SST-sensitive currents. When the spontaneous induction with GTP$\gamma$S was maximum, SST did not induce any outward currents.

These results indicate that SST decreases the postsynaptic membrane excitability of SG neurons by G-protein mediated activation of an inwardly-rectifying K$^+$ ion conductances.

keywords : Substantia gelatinosa neuron, somatostatin, brain slice, patch clamp, $I_{\text{Kir}}$

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