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Development of NO-Ergic Synaptic Transmission in Sympathetic Neurons of Mammals: Immunohistochemical Study

Authors : Konstantin Yu. Moiseev, Antonina F. Budnik, Andrey I. Emanuilov, Petr M. Masliukov

Abstract : The vast majority of sympathetic ganglionic neurons are catecholaminergic. Some sympathetic neurons lack catecholamines and mostly use acetylcholine as their main neurotransmitter. Some cholinergic postganglionic neurons also express neuronal nitric oxide synthase (nNOS). Preganglionic sympathetic neurons are cholinergic and most of them are also nNOS-immunoreactive (IR). The purpose of this study was to gain further insight into the neuroplasticity of sympathetic neurons during postnatal ontogenesis by comparing the development of pre- and postganglionic neurons expressing nNOS in different mammals. nNOS was investigated by immunohistochemistry in the sympathetic superior cervical ganglion (SCG), stellate ganglion (SG), celiac ganglion (CG) and spinal cord from rats, mice and cats of different ages (newborn, 10-day-old, 20-day-old, 30-day-old, 2-month-old and 2-year-old). In rats and mice, nNOS-positive neurons were not found in sympathetic ganglia from birth onwards. In cats, non-catecholaminergic nNOS-IR sympathetic ganglionic neurons are present from the moment of birth. In all studied age groups, substantial populations of nNOS-IR cells (up to 8.3%) was found in the SG, with a much smaller population found in the SCG (<1%) and only few cells observed in the CG. The percentage of nNOS-IR neurons in the CG and SCG did not significantly change during development. The proportion of nNOS-IR neuron profiles in the SG increased in first 20 days of life from 2.3±0.15% to 8.3±0.56%. In the SG, percentages of nNOS-IR sympathetic neurons colocalizing vasoactive intestinal peptide increased in the first 20 days of life. Choline acetyltransferase (ChAT)-IR and calcitonin gene-related peptide-IR neurons were not observed in the sympathetic ganglia of newborn animals and did not appear until 10 days after birth. In the SG of newborn and 10-day-old kittens, the majority of NOS-IR neurons were calbindin (CB)-IR, whereas in the SCG and CG of cats of all age groups and in the SG of 30-day-old and older kittens, the vast majority of NOS-IR neurons lacked CB. In newborn mammals, the most of sympathetic preganglionic neurons in the nucleus intermediolateralis thoracolumbalis pars principalis (nucl.ILp) were nNOS-IR. The percentage of nNOS-IR neurons decreased and the same parameter of ChAT-IR neurons increased during the development. We conclude that the development of nNOS-IR preganglionic and ganglionic sympathetic neurons in different mammals has time and species differences.

Keywords : sympathetic neuron, nitric oxide synthase, immunohistochemistry, development
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