

Abstract

In the mammalian retina, the light response of the photoreceptors (rods and cones) is processed by an elaborate neuronal network. For many years it has been thought that in the mammalian retina rod and cone signals are relayed by different types of bipolar cells. Since a few years, however, there is strong evidence that in the mammalian retina certain cone bipolar cells receive input from both rods and cones and thus provide for the so called “alternative pathway” of rod photoreceptors. In the present study, cell types were identified that provide for this alternative rod pathway. For these purposes vertical sections and wholemount preparations of the mouse retina were immunohistochemically processed and the labelled cell types were analyzed by confocal laser scanning microscopy. Synaptic connections were confirmed by electron microscopy. Two OFF-bipolar cell types were identified, that form flat contacts to rod and cone endfeet and whose axon terminals stratify within sublamina 2 of the inner plexiform layer. These cells were identified as type 3a- and type 3b-cone bipolar cells. In this study type 3b-cone bipolar cells are described for the first time. Additionally a ganglion cell type was identified whose dendrites co-stratify with the axon terminals of type 3-cone bipolar cells. This ganglion cell type might be postsynaptic to type 3 cells and thus could serve as an output neuron of the alternative rod pathway.

For the immunohistochemical labeling of bipolar and ganglion cell types antibodies against hyperpolarization-activated and cyclic nucleotide-gated channels (HCN-channels) were used. For these purposes polyclonal and monoclonal antibodies were generated and characterized immunohistochemically and immunocytochemically as well as by Western blot analysis. The expression patterns of the four different HCN-channel isoforms HCN1 - 4 were analyzed in the adult mouse retina as well as in defined postnatal states by immunohistochemical methods. All four HCN-isoforms are differentially expressed in the adult retina. HCN-channels can already be detected at a developmental state when no light responses can be generated. In the developing photoreceptor cells HCN1 is expressed at the day of birth (P0). In bipolar cells and ganglion cells HCN-channels can be found in the second postnatal week.