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Glial-dependent clustering of voltage-gated ion channels in Drosophila precedes myelin formation

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Neuronal information conductance depends on transmission of action potentials. The conductance of action potentials is based on three physical parameters: The axial resistance of the axon, the axonal insulation by glial membranes, and the positioning of voltage-gated ion channels. In vertebrates, myelin and channel clustering allow fast saltatory conductance. Here we show that in Drosophila melanogaster voltage-gated sodium and potassium channels, Para and Shal, co-localize and cluster in an area of motor axons resembling the axon initial segment. Para but not Shal localization depends on peripheral glia. In larvae, relatively low levels of Para channels are needed to allow proper signal transduction and nerves are simply wrapped by glial cells. In adults, the concentration of Para at the axon initial segment increases. Concomitantly, these axon domains are covered by a mesh of glial processes forming a lacunar structure that serves as an ion reservoir. Directly flanking the voltage-gated ion channel rich axon segment, the lacunar structures collapse forming a myelin-like insulation. Thus, Drosophila development may reflect the evolution of myelin which forms in response to increased levels of clustered voltage-gated ion channels.

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