Abstract

Patients suffering from spinal cord injury experience physical, social, and vocational impairment. It is a condition often causing a permanent disability mainly due to axonal regeneration incapability in the central nervous system. The primary insult simultaneously damages cells in the lesion site and initiates a cascade of secondary cellular, vascular, and biochemical events extending the injury. These pathophysiological mechanisms are examined using multiple approaches. Novel imaging techniques complement classical histopathological methods and neuroanatomical tracing. Recent studies employ transgenic mice and two-photon microscopy to observe single cells in the injury site and the nearby vasculature *in vivo* longitudinally. *In vivo* optical imaging enables studying of axonal responses, such as degeneration, regeneration, and neurovascular interactions. It also gives an opportunity to assess the effects of applied drugs directly. New findings lead to a better understanding of the pathophysiology of spinal cord injury, resulting in the ability to develop other therapeutic strategies improving the outcome after injury.

Keywords: spinal cord injury, pathophysiological mechanisms, axonal regeneration, Wallerian degeneration, animal models, transgenic mice, *in vivo* imaging, two-photon excitation microscopy