Neural circuitry of the adult rat central nervous system after spinal cord injury: a study using fast blue and the bartha strain of pseudorabies virus.

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Abstract

The distribution of retrogradely and transneuronally labeled neurons in the adult rat brain and spinal cord after contusive mid-thoracic spinal cord injury (SCI) was studied using Fast Blue (FB) and the Bartha strain of pseudorabies virus (PRV), respectively. When FB was injected into the distal spinal cord at 2 days after graded SCI at the 10th vertebral level, labeled neurons were consistently found 7 days later in supraspinal areas that normally project to the spinal cord. The number of FB-labeled neurons decreased as the injury severity increased. An inverse correlation between the number of FB-labeled neurons and injury severity was seen in most investigated brain nuclei with coefficient of correlations (r) ranging from -0.84 in the red nucleus to -0.92 in the raphe nuclei. The coefficient of correlation was relatively poor in the motor cortex (r = -0.63), where a mild injury (6.25 g.cm) resulted in a 99% damage of the corticospinal tract. Such a prominent difference between the corticospinal tract and other descending pathways can be related to the difference in location of these pathways within the adult rat spinal cord. When PRV was injected into the right sciatic nerve one month after the injury, labeled cells were consistently identified 5 days later in the spinal cord rostral to the injury and in certain supraspinal regions that regulate autonomic outflow. In these nuclei, the distribution and number of PRV-labeled neurons markedly decreased after SCI as compared to the control group. In contrast, PRV-labeled neurons were inconsistently found in the supraspinal nuclei that contribute to somatic motor outflow in normal controls and no labeling was observed in these nuclei after injury. These results demonstrate that (1) a proportion of neural network across the injured spinal cord has been spared after acute contusive SCI, (2) the proportion of spared axons of a particular pathway is closely correlated to the injury severity and the position of that pathway, and (3) the transneuronal labeling method using PRV may provide a unique approach to investigate multi-synaptic neural circuitry of the central autonomic control after SCI, but its application to the somatic motor system is limited.