Sole use of impaired limb improves recovery in spinal cord injury

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A new study finds that following minor spinal cord injury, rats that had to use impaired limbs showed full recovery due to increased growth of healthy nerve fibers and the formation of new nerve cell connections. Published in the September 17 issue of *The Journal of Neuroscience*, these findings help explain how physical therapy advances recovery, and support the use of rehabilitation therapies that specifically target impaired limbs in people with brain and spinal cord injuries.

"After brain and spinal cord injuries, exercise-based physical therapy is the primary rehabilitative strategy in use today," said Stephen Strittmatter, MD, PhD, at Yale University School of Medicine, an expert unaffiliated with the study. "These therapies are so beneficial to patients, but the anatomical and molecular bases of improvement have not been clear," Strittmatter said.

The researchers, led by Irin Maier and senior researcher Martin Schwab, PhD at the University of Zurich and the Swiss Federal Institute of Technology, tested rats with minor surgical injuries to the spinal cord that impaired the use of one forelimb. Slings were placed on the rats that restricted the use of either the injured or uninjured limb. After three weeks, researchers removed the slings and tested the rats on an elevated horizontal ladder.

Rats that relied on their impaired limb because use of their unimpaired limb was restricted showed complete functional recovery: they negotiated the ladder as well as rats that had not been injured. In contrast, rats that had not worn slings and those that wore slings restricting the use of the injured limb performed poorly, showing difficulty grasping and negotiating the horizontal rungs of the ladder.

In all of the rats, healthy nerve fibers, or axons, grew into injured regions of the spinal cord. However, rats that relied on their injured limb showed the most extensive nerve growth. "The study shows that when the axons that remain after a spinal cord injury are more active — because the animal is forced to use them — they grow more. This seems to help the animal recover more control of their movements," said John Martin, PhD, at Columbia University, an expert unaffiliated with the study.

These nerve fibers formed more connections, or synapses, in rats relying on their injured limb compared with those relying on their uninjured limb. This finding suggests that forced limb use encourages healthy nerve cells to form new synapses with cells affected by spinal cord injury, perhaps rerouting and rewiring damaged spinal cord circuits that are important for movement.

Using gene chip technology, the researchers found that forced limb use turned on or turned off genes known to be involved in nerve fiber growth and synapse formation in the spinal cord. Knowing which genes are involved in recovery from spinal cord injury may help researchers develop new drug treatments.

"This study shows that a behavioral approach is remarkably effective in promoting both axon growth and recovery after injury," said Martin. "We know that physical therapy is effective after brain and spinal injuries. But these new results suggest that a more aggressive therapy, in which the unimpaired limb is prevented from use and the impaired limb is forced to be used, might lead to new neural connections," he said.

Source: Society for Neuroscience