X rays speed healing of rat spinal cords

From the imaging of bones to the killing of dangerous cancer cells, X rays have become a powerful medical tool since their discovery more than a century ago. A provocative report now offers the surprising claim that a timely administration of X rays to an injured spinal cord can aid its healing and encourage the development of new nerve fibers to replace destroyed ones.

The X-ray therapy, conducted on a small number of rats whose spinal cords were partially or completely severed, has generated both interest and skepticism among scientists.

"I don't dismiss the report, but it's our responsibility to verify and repeat this work. It is controversial. Anytime you apply a negative therapy like radiation, which kills cells and damages tissues, you have to be concerned about long-term effects," says Barth A. Green, a neurosurgeon at the University of Miami Medical School and head of the Miami Project to Cure Paralysis.

Nurit Kalderon, now at the Memorial Sloan-Kettering Cancer Center in New York, developed the idea of X-ray therapy for spinal cord injuries while at Rockefeller University, also in New York. Like other parts of the central nervous system, spinal cords are unable to spontaneously regenerate axons, the long fibers that connect one nerve cell to another (SN: 9/21/96, p. 180).

Kalderon and other researchers have observed that damaged rat spinal cords show signs of healing immediately after injury. Yet a wave of degeneration that sets in several weeks later at the site of the injury eventually stops any recovery in its tracks, she says.

Working with Zvi Fuks of Memorial Sloan-Kettering, Kalderon discovered that X rays, when applied to a rat's spinal cord about 3 weeks after it was cut, can limit observable signs of this decay. Applied earlier or later, the X rays have little effect, she says.

The X-ray therapy also seems to encourage growth of new axons across the injury site. Dye injected into nerve cells on one side of the severed spinal cord appears later in nerve cells on the other side, presumably by traveling through axons that had grown across the gap, Kalderon and Fuks report in the Oct. 1 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

In a second report in the journal, the researchers offer evidence that the axon regrowth improves function in the paralyzed rats. By stimulating parts of each rodent's brain, the scientists tested whether they could elicit electrical activity in muscles connected to the spinal cord beyond the site of the cut. They found no response in the untreated rats, but in eight of nine rats treated with X rays, at least one muscle showed signs of electrical activity. In four of those rats, three or more muscles responded.

A few of the paralyzed rats treated with X rays even regained partial control of their hind limbs and the ability to support weight on them, says Kalderon.

Kalderon speculates that the X rays destroy cells called reactive astrocytes, which may contribute to scarring at the site of a spinal cord injury and to the eventual degenerative response.

Wise Young of New York University Medical Center cautions that it is still unclear which kinds of cells the X rays affect. He plans to try to confirm the therapy's success by applying it to rats with a crushed spinal cord, an injury more closely resembling the typical spinal cord injury in people.

Michael Walker of the National Institute of Neurological Disorders and Stroke in Bethesda, Md., stresses that it is premature for physicians to treat spinal cord injury patients with X rays.

He notes that X rays, long used to treat spinal cord tumors, can at certain doses harm blood vessels and the insulating sheath that are vital to the cord's health. Such damage may not be apparent until months or years after therapy, he adds. *—J. Travis*

Glimpses inside a tiny, flashing bubble

Bombarded with an intense sound wave, a small gas bubble suspended in water can emit a string of extremely short, bright pulses of light. Known as sonoluminescence, this conversion of sound into light occurs during the rapid and violent contraction of the bubble as it oscillates in step with the sound wave (SN: 4/29/95, p. 266).

How the collapse of a bubble during contraction generates a flash of light, however, remains largely a mystery. Now researchers have obtained new experimental evidence that may illuminate key characteristics of the light source.

One group has discovered that the bubble wall separating the gas from the surrounding liquid may not always be perfectly spherical during collapse, as theorists had generally supposed. Another team has found that putting the bubble into a strong magnetic field can drastically decrease light emission.

Physicists Keith Weninger, Seth J. Putterman, and Bradley P. Barber of the University of California, Los Angeles used several photodetectors surrounding a flask of water to determine the uniformity of light emission from a sound-driven oscillating bubble. In some cases, they detected variations in light intensity in different directions, suggesting that the bubble wall was nonspherical—possibly squashed into a slightly ellipsoidal shape—during collapse. In other cases, the bubbles stayed spherical.

Their measurements, reported in the September PHYSICAL REVIEW E, also indicated that ellipsoidal deformations could persist for up to 100 successive contractions and light flashes.

"This work is interesting because it establishes a new diagnostic [tool] that can be used to study a lot of different aspects of sonoluminescence," says Michael J. Moran of the Lawrence Livermore (Calif.) National Laboratory.

The pattern of light emission indicates that the nonspherical bubble wall refracts radiation coming from a small, spherical region of hot gas deep inside a bubble, Putterman and his colleagues conclude.

The observation that a collapsing bubble can actually appear perfectly spherical, at least sometimes, is surprising, Putterman says. "You've got a supersonic implosion, with the bubble wall collapsing at over four times the speed of sound. Yet, at the moment when the bubble hits its minimum radius and the light comes, we get a highly spherical state a large percentage of the time."

Though Putterman and his coworkers can now determine whether bubble collapse is spherical, they can't yet predict or control the shape in any given situation. "The system seems to hop between a spherical state and another state," Putterman notes. However, "we don't know what to do to force it from one state to the other."

Because electric charges accelerate during the generation of light flashes, studying the effect of an external magnetic field on the system could also lead to insights into sonoluminescence.

Woowon Kang and his coworkers at the University of Chicago have investigated bubble oscillations in uniform magnetic fields as strong as 20 teslas, more than 400,000 times Earth's magnetic field. Preliminary results indicate that a sufficiently strong magnetic field can suppress sonoluminescence, Kang says.

"This is an exciting result," Putterman comments.

Kang is now interested in checking whether a weaker magnetic field that has a definite direction affects the distribution of light emitted by an oscillating bubble. *—I. Peterson*