Physiology of the phantom limb

Nearly everybody who has had a leg or arm amputated sometimes experiences the sensation or feeling that they still have their missing limbs. Some of them experience pain in their "phantom limbs." The phantom limb phenomenon is eery, but methods for relieving phantom limb pain are equally intriguing. On and off since the 1880's, for instances, doctors have had amputees hit their stumps with a mallet and peg. Their pain increased at first, then went away for some hours.

A physiological investigation of the phantom limb phenomenon has now been conducted in animals by Patrick D. Wall of University College in London and by Michael Gutnick of Hebrew University in Jerusalem. Their studies, reported in the April 26 NATURE, shed light on how phantom limbs occur in people and why certain forms of therapy for phantom limb pain probably work. The nature of their experiments is such that they can probably now be carried out in human amputees.

In most limb amputations, the cut nerves end up in firm swellings called neuromas. One assumes that these nerve fibers are able to work and that they frequently fire off impulses to the central nervous system and hence create the sensation of a limb still being present. Not only is this a likely assumption, but it is reinforced by the effect of blocking the cut nerves of a neuroma with a local anesthetic. When nerve fibers are blocked this way, there is a keen reduction in sensation or a total loss of the sensation of a phantom limb. It is apparent that the sensation was the result of nerve fibers within the neuroma continually firing off nerve impulses.

Wall and Gutnick have now confirmed that these events occur, at least in experimental animals. They induced neuromas in the cut sciatic nerves of rats. The sciatic nerve is the largest nerve in the body; it runs through the buttock down the back of the thigh. They recorded the activity of the nerves in the animals' neuromas and found that the nerves were indeed continually active. And the nerves' activity could be stopped by anesthetizing the neuromas.

They have also come up with an explanation for why hitting a stump with a mallet and peg thwarts phantom limb pain. They divided the nerves in the neuromas so that they no longer reached the spinal cord. They placed electrodes on the nerves and stimulated them rapidly for a few seconds. This electrical excitation triggered a marked reduction in the nerves' spontaneous activity, suggesting that if nerves can be induced to fire off maximally, as via mallet and peg, they may stop firing spontaneously for a prolonged period and hence stop causing pain.

This finding also suggests how electrical stimulation of painful amputation stumps often helps get rid of pain. Electrical stimulation simply keeps nerves from firing off spontaneously. This explanation differs from that previously provided by Wall's gate-control theory of pain, which states that stimulation of large peripheral nerves cuts off central nerve impulses that cause pain. □

Tonsils: Cell-immunity role confirmed

Tonsils have been known for some time to make antibodies against bacteria. But despite the fact that tonsils are masses of lymphoid tissue and contain some 200 million lymphocytes each, their role in cellular immunity has been unclear. In cellular immunity, lymphocytes—a kind of white blood cell—attack cells infected by virus.

Now a new technique to measure the function of lymphocytes has been used by Rodrigo C. Hurtado and his group at Georgetown University School of Medicine to show that tonsils do indeed provide lavish cellular immunity. They reported their findings last week at a meeting of the Society for Pediatric Research in Washington.

"The demonstration of cell-mediated immunity in the tonsils," Hurtado said, "points out their role in defense against a variety of infections such as the common cold, herpes, measles, influenza and polio. They may also be a barrier to the development of certain kinds of malignancy. Following removal of tonsils, there is clinical evidence of increased malignancy although the reasons are not well understood. . . . Physicians should think long and hard before removing them."

They chose a group of 12 patients ages five to twenty-two years who were admitted to Georgetown University Hospital for a tonsillectomy. None had a history of measles or rubella vaccination. Lymphocytes were taken from their blood just before surgery. After surgery, lymphocytes were taken from their removed tonsil tissue.

A comparison of the action of the two kinds of lymphocytes showed the following results: Both were equally effective in recognizing and attacking target cells infected with rubella virus, which identified the specific function of tonsil tissue in local cellular immunity. In two standard tests of cellular immunity, lymphocytes from the tonsils showed characteristics similar to those of lymphocytes from the blood. Each patient studied did not have equal amounts of immune response from tonsil and blood lymphocytes, suggesting that people's immune defenses vary. In other words, one person may have stronger protection in the blood, another in the tonsils.

The study also showed there is no correlation between antibody protection provided by tonsils and cellular immunity provided by tonsils, underscoring other evidence that antibody immunity and cellular immunity are relatively independent of each other. □

Proton beams and the Fermi machine

The National Accelerator Laboratory at Batavia, Ill., has the world's most energetic beam of protons (400 billion electron-volts). Now it also delivers the world's largest number of protons per pulse. Intensity of the beam proved something of a problem in the early days of operation, but NAL reports that it now has the machine to where it will deliver 10 trillion protons per pulse. The higher intensity should make it easy to find rare phenomena at high energy.

High intensity is very important in searches for rare physical processes and new particles.

On May 11 the laboratory was formally dedicated. At the dedication it was renamed the Fermi National Accelerator Laboratory in honor of the late Enrico Fermi, who led the team that produced the world's first nuclear reactor. □

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