# Surgery, without the scalpel

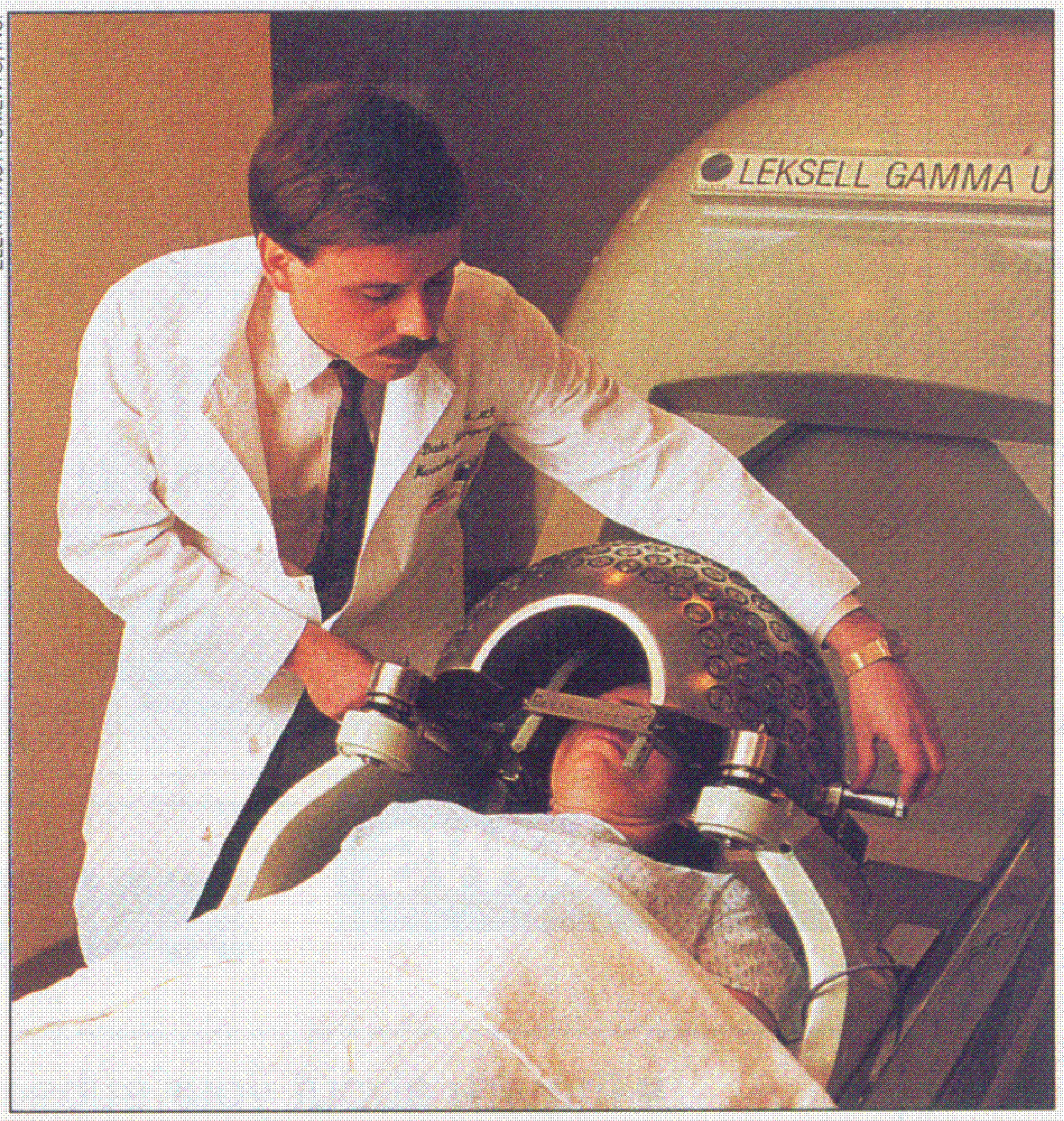
**MEDICINE** ■ By focusing precise beams of radiation, doctors can operate on previously inaccessible reaches of the brain

■ It sounds like the stuff of science fiction: A 27-year-old man suffering from an abnormality in a critical part of the brain is wheeled, fully conscious, up to a 20-ton hulk of equipment. While a three-dimensional image of his brain is monitored on a computer screen from an adjacent room, doctors flick a switch. Twenty minutes later—without a single incision—the delicate operation is complete.

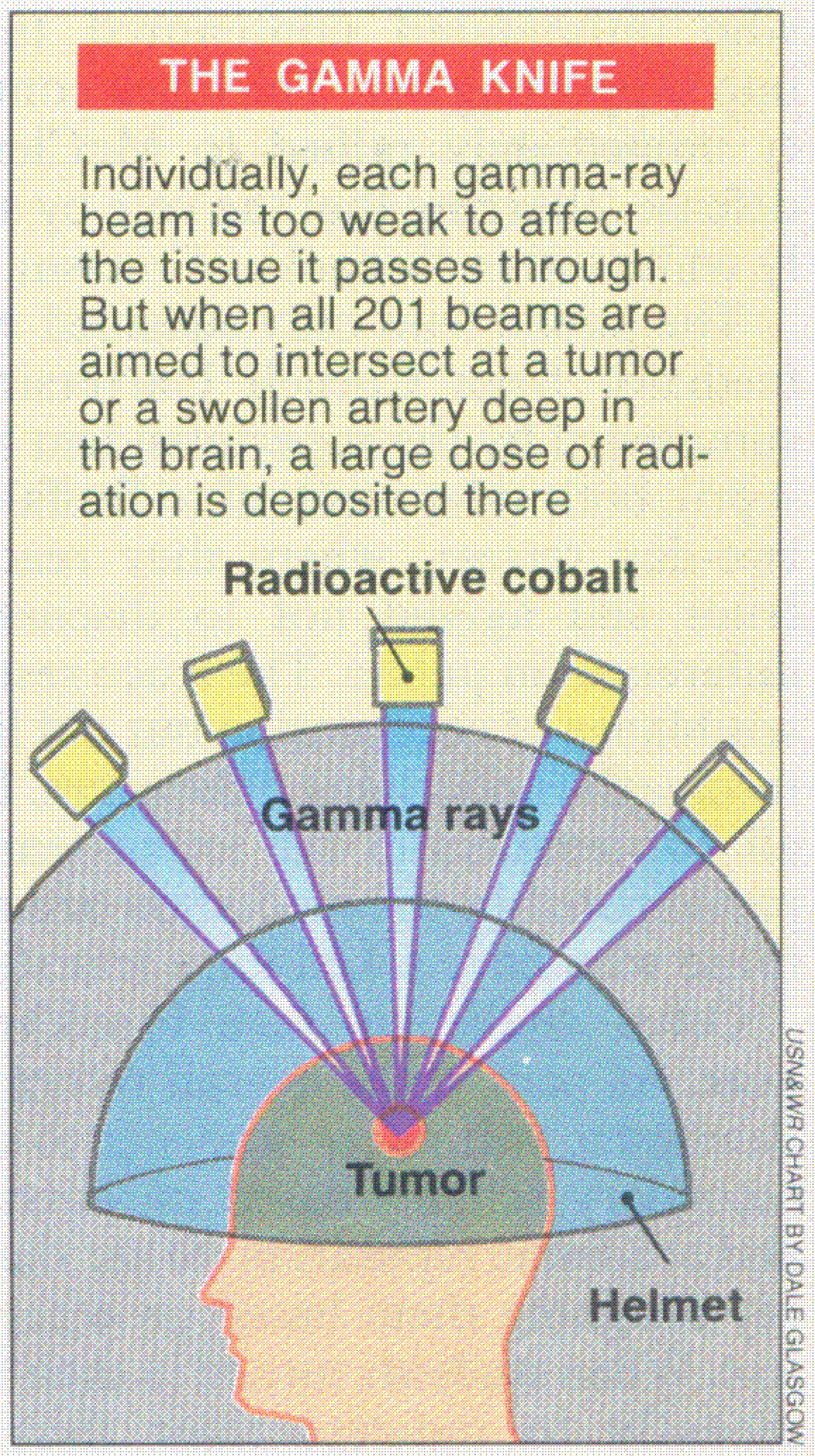
Brain surgery without a scalpel has already been carried out in thousands of patients. Using finely focused beams of radiation to take the place of the surgeon's knife, the new techniques allow doctors to reach previously inaccessible regions of the brain, reduce the chances of damaging nearby healthy tissue and speed recovery. "Until these techniques came along," says Dr. Jacob I. Fabrikant, a radiologist at the University of California at Berkeley, "there was nothing we could do in inoperable cases—people were sent home with no hope."

The 27-year-old man was one of 2,500 patients a year in the United States who suffer from a dangerous condition called arteriovenous malformations—masses of engorged blood vessels in the brain. The main concern is that the vessels will rupture, causing death or brain damage similar to a stroke. In his case, doctors estimated that conventional brain surgery carried a 1-in-3 chance of permanent brain damage—causing paralysis or loss of speech—and a 1-in-30 chance of death. But using the latest of the nonsurgical techniques, called the gamma knife, doctors at Presbyterian-University Hospital of Pittsburgh last month were able to perform the operation with a much higher promise of a successful outcome. Of more than 2,000 patients treated with the gamma knife, none has died and only 3 percent have suffered neurological impairment.

**Stronger than X-rays.** The gamma knife only recently made its clinical debut in the United States, but it is the result of two decades of research by Swedish scientists Lars Leksell and Börje Larsson. The device consists of a helmet with 201 holes—these are portals for radioactive cobalt, which emits gamma rays, a form of radiation with greater energy than X-rays. Guided by three-dimensional imaging techniques, doctors can aim the beams precisely on the site of the abnormality deep within the brain. Only at that point—where all 201 beams intersect—is the dose of radiation intense enough to have an effect. "The amount of radiation reaching the rest of the brain is minuscule—comparable to what you'd receive from cosmic rays at a high elevation," says Dr. Ladislau Steiner, who pioneered clinical applications of the gamma knife at Stockholm's Karolinska Institute. The radiation does not destroy the arteriovenous malformation outright; rather it prompts cells in the lining of the vessels to proliferate, which over a year or so seals off blood flow into the region.




Helmet aims 201 separate beams onto the target




In a parallel development, other doctors are utilizing high-energy charged particles, such as protons, to perform the same function. At Harvard University and the University of California at Berkeley, massive cyclotrons generate the charged particles and accelerate them to high energies. By fine-tuning the amount of energy in the beam, clinicians can control the distance the particles travel before depositing the bulk of their energy in a single burst. With the patient properly aligned relative to the beam, the release of energy can be confined to pea-size targets inside the brain.

Few doctors expect these techniques to make the scalpel obsolete altogether. Microsurgery, which has advanced rapidly in recent years, produces more-immediate results and may prove less risky if an abnormality is in an easily accessible part of the body. But researchers are enthusiastic about the prospect that uses of the gamma knife and charged particles will continue to expand. Already, the technique has proved more than 80 percent successful in treating slow-growing tumors of the pituitary gland, the covering of the brain and the cranial nerves.

Fast-growing tumors, which branch out in all directions, are more difficult to target with radiation. But with further refinements in radiosurgery, coupled with advances in diagnostic imaging, "virulent tumors may yet yield to this approach," predicts Fabrikant.

A greater challenge, however, may be to bring down the price of the technology. The cyclotrons needed to produce particle beams run as high as $25 million. The gamma knife costs $2.5 million. But there's hope that the same results may be achieved for only $20,000 with new equipment that can tightly focus beams of X-rays. These devices could be attached to the X-ray-producing linear accelerators that are already standard equipment in many hospitals for conventional radiation therapy of cancer patients. If the new method can be shown to be safe and effective, noninvasive brain surgery could spread beyond a handful of medical centers to become a widely available treatment. ■

by Kathleen McAuliffe