Nuclear Medicine Lays the Groundwork for "Virtual" Surgery

While the emerging field of virtual reality is progressing towards the development of real-life "teleoperating" devices which will allow surgeons to view three-dimensional images of organs in front of them and execute surgical movements via computer, nuclear medicine is already enabling some surgeons to perform "virtual" surgeries with greater precision and less risk to the patient. As reported in a recent article in the *Washington Post*, neurosurgeons and radiologists are using CT and MRI scans to produce three-dimensional images that can be maneuvered on computer screens to map out the least invasive path to excise tumors located in deep regions of the human body. These images are increasingly being used in conjunction with rapidly advancing guided-imaging technologies to allow surgeons to track their movements on deep tumors. While excising deep tumors, neurosurgeons can gauge the position of their instruments against MR images that were taken prior to surgery. The end result is that surgeons can perform surgery quicker with higher precision and less risk of damaging healthy tissues. Lucia Zamorano, a neurosurgeon at the Wayne State University Medical School, has been quoted as saying that "this type of guided-imaging surgery [allows us] to excise lesions deeper in the brain and do less damage to surrounding tissues."

CT scans are likewise finding their way into the virtual operating room. In the same *Washington Post* article, Jane Stevens notes that three-dimensional CT bone images are enabling orthopedic surgeons in Sacramento, Boston and Pittsburgh to compare the fit of hip replacements against the CT image. These surgeons can then use the Robodoc, a robotic surgeon still in development, to work on the CT image and drill the holes in the femur which are used to keep the hip replacement firmly in place. Although these static three-dimensional images will inevitably be replaced by real-time technologies and organ simulators which enable surgeons to do test-runs on damaged organs, Zamorano and others are currently finding widespread use for nuclear scans in the "virtual" treatment of brain tumors, chronic pain and Parkinson's disease. ■

OVERHEARD

The field of medical imaging has certainly made major advances since the discovery of x-rays by Roentgen some 100 years ago. The basis of medical imaging, however, is to use intrinsic differences in some physical property of the patient, such as the linear attenuation coefficient for x-rays or the acoustic impedance for ultrasonic waves, and generate an image that may distinguish normal from pathologic tissue.... Although it is true that computers are being used more and more in medical imaging systems, in our opinion it is important to not lose sight of the fact that the underlying physics of the imaging modality is what dictates the diagnostic capability provided by the images, and ultimately the contribution to medical care.

—Letter to the Editor, Science, November 17, 1995

An advisory panel to the Food and Drug Administration recommended last week that the agency approve an ultrasound device that can determine whether a suspicious breast lump is benign or cancerous. The technique, high-definition imaging (HDI), could reduce the 700,000 biopsies performed each year. Physicians routinely use mammograms to find small lumps in the breast. But mammograms can't tell if the lump is cancerous, so surgeons must perform a biopsy on the lump. In a test of over 900 breast lumps, HDI's manufacturer, Advanced Technology Laboratories of Seattle, reported 99.5% accuracy in diagnosing benign lumps. The technique effectively picks out benign, fluid-filled cysts but it is less successful at distinguishing between cancers and other kinds of benign growth.

—Science News (SN, December 1995)

Last month, at an international meeting of some 600 radiation scientists, an expert panel put its imprimatur on a scientific conclusion that has recently gained increasing acceptance: The explosive increase in childhood thyroid cancer in Belarus, the Ukraine and the Russian Federation—the countries most contaminated by the 1986 Chernobyl nuclear accident—can be directly linked to the released radiation, and most likely to contamination by radioactive iodine isotopes.... But even though radiation is the main suspect in this thyroid cancer epidemic, questions remain about which radioactive isotopes are responsible and whether other factors—such as industrial pollution or a genetic predisposition to thyroid cancer—might help explain why the children are so susceptible to the disease.

—Science, December 15, 1995

Once upon a time, when fuel prices were high, nuclear fast-breeder reactors enjoyed brief fame based on a singular claim. While producing energy by splitting some uranium atoms, they could create an even larger number of plutonium atoms. This plutonium could then be turned into fuel to generate much more energy. Economics and politics, though, have not been kind to breeder reactors. With oil prices at historic lows and former cold war adversaries awash in plutonium and uranium, the idea has seemed to lose considerable luster. In February 1994, Secretary of Energy Hazel R. O'Leary ended U.S. research into breeder technology—after some $9 billion had been spent on it.

—Scientific American, January 1996