Proton treatment could replace x-ray use in radiation therapy

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Scientists at MIT, collaborating with an industrial team, are creating a proton-shooting system that could revolutionize radiation therapy for cancer. The goal is to get the system installed at major hospitals to supplement, or even replace, the conventional radiation therapy now based on x-rays.

The fundamental idea is to harness the cell-killing power of protons -- the naked nuclei of hydrogen atoms -- to knock off cancer cells before the cells kill the patient. Worldwide, the use of radiation treatment now depends mostly on beams of x-rays, which do kill cancer cells but can also harm many normal cells that are in the way.

What the researchers envision -- and what they're now creating -- is a room-size atomic accelerator costing far less than the existing proton-beam accelerators that shoot subatomic particles into tumors, while minimizing damage to surrounding normal tissues. They expect to have their first hospital system up and running in late 2007.

Physicist Timothy Antaya, a technical supervisor in MIT's Plasma Science and Fusion Center, was deeply involved in developing the new system and is now working to make it a reality. He argues it "could change the primary method of radiation treatment" as the new machines are put in place.

The beauty of protons is that they are quite energetic, but their energy can be controlled so they do less collateral damage to normal tissues, compared to powerful x-ray beams. Protons enter the body through skin and tissue, hit the tumor and stop there, minimizing other damage.

Protons are far more massive than the photons in x-rays, and the x-rays tend to pass directly through tissues and can harm living cells along the entire path. The side effects often include skin burns and other forms of tissue damage.

The new machines, in fact, should allow radiation specialists to deposit a far bigger dose of killing power inside the tumor, but spare more of the surrounding normal tissues. This is expected to increase tumor control rates while minimizing side effects.

Because of their high energy and controllability, protons have been used as anti-cancer bullets in the past, with promising results. But medical centers can't easily come up with the $100 million or more needed to build a proton machine dedicated to this medical use. That's because protons are produced inside the huge, expensive atomic accelerators that are usually employed at major atomic research centers, including national laboratories.

Now, Antaya and his colleagues at MIT and at Still River Systems Inc. think they can provide the new machine for far less money, have it occupy just one moderate-size hospital treatment room, and achieve better results than x-ray therapy. MIT is licensing the technology to Still River Systems.

Industry is already showing acute interest in the new technology because more than half of all cancer patients are now treated with radiation, meaning there are two million radiation patients worldwide. That offers a huge market for an effective new radiation system, and the directors of major cancer research and treatment centers are already enthusiastic, Antaya said.

Antaya recalled that the initial push to build a new proton-making system came from a radiation physicist, Kenneth Gall, at the University of Texas at Dallas Medical Center. "He had a good idea for a single-room proton treatment facility, but hadn't found anyone who thought it was possible to build," Antaya said. Gall is now at Still River Systems as a co-founder.

In his own research experience, Antaya had worked with new types of cyclotrons -- they were called "atom smashers" years ago -- using new "superconducting" coils to generate the necessary magnetic fields. As a result, he could see a "nexus between all the required technologies and how we could pick a reasonable set of properties, with a good chance of being successful," he said.

Building it is quite a challenge, however. "This is an accelerator that's going to be in the room with the patient, so it's quite a difficult design exercise" just in terms of safety issues, Antaya said. But he and his colleagues are betting it will work as expected.

The magnet work of the Technology and Engineering Division of the Plasma Science and Fusion Center, led by senior research engineer Joseph Minervini, is key to the new system. That work has been funded by the U.S. Department of Energy Office of Fusion Energy Science.

Source: MIT

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