Medical Physics Team at UNM Cancer Center Expands Treatment Choices

From stereotactic radiosurgery to hippocampal-sparing treatment, the medical physics team provides new radiation therapy options

FOR IMMEDIATE RELEASE:

June 17, 2014 — Albuquerque, NM (UNM Cancer Center) — Phoebe T. Ward, Jr. was the first patient to receive stereotactic radiosurgery at the University of New Mexico Cancer Center. The procedure killed the tumor in Ms. Ward’s brain by hitting it with x-rays. It took no more than 15 minutes but preparation for the procedure took months.

“It’s a single treatment and there’s no way to remove the radiation,” says Eder Calderon. “So we have physicists doing checks. We have the radiation therapists doing checks. We also include the radiation oncologist in some of those checks.” Mr. Calderon is a medical physicist in the Department of Radiation Oncology at the UNM Cancer Center. He skillfully controls the ionizing radiation delivered to a person with cancer to noninvasively kill tumors, including brain tumors. He and the UNM Cancer Center medical physics team develop procedures to expand how they use the existing radiation equipment, giving people with cancer more options. Stereotactic radiosurgery is one of the new procedures they’ve put in place; hippocampal-sparing radiation is another. Ms. Ward has received both.

One precise dose
Radiosurgery and radiation therapy kill cancer cells with radiation, but they require vastly different procedures. People receiving radiation therapy get many small doses over several weeks. The radiation targets the tumor but some goes into the nearby healthy tissue. Normal, healthy cells can repair themselves more quickly than cancerous ones, so cancer cells around the tumor also die but the healthy tissue recovers. Using the same idea, some radiation treatments target large volumes of the body to kill lurking cancer cells that are too small to see on scans.

Radiosurgery is far more precise. “We make it very conformal around the target,” says Mr. Calderon. Radiosurgery targets the tumor but covers as little of the surrounding tissues as possible. This precision is necessary because radiation oncologists give the treatment in a single dose. The radiation must kill the tumor cells but must spare the healthy cells around them.

Both procedures require the medical physics team to integrate two sets of systems. One set of systems controls the radiation. The other set of systems controls how the radiation reaches its target, the cancer tumor.
“Controlling” radiation by filtering it
Lenses that can bend visible light, such as eyeglass lenses, are inexpensive compared with lenses that bend x-rays. X-ray lenses are more costly and difficult to produce because x-rays pass through most objects without deflecting much. So instead of trying to bend x-rays, radiation equipment filters them.

The x-ray source inside radiation machines gives off x-rays in all directions. To control the direction of the radiation, heavy shielding around the source blocks the x-rays in all directions except one. A tungsten cone fits onto the shielding to filter the x-rays further so that only a single, directed beam of x-rays escapes the machine.

The shape of the cone and the hole in the middle of it affect how sharp or diffuse the resulting beam of x-rays is. For stereotactic radiosurgery, Mr. Calderon explains “we’re going to have very, very sharp gradients in the edges of that hole.” The medical physics team at UNM Cancer Center can make the gradient fit within millimeters. The x-ray beam for radiation therapy can be more diffuse — its gradient is larger so it’s more like the edges of a beam from a flashlight.

Getting a beam of radiation where it needs to be is only part of the task. The medical physics team also needs to know how much ionizing radiation actually reaches the target. Ionizing radiation, x-rays and visible light are forms of radiation and all radiation is made up of vibrating particles called “photons.” But the photons in visible light and x-rays do not have enough energy to remove electrons from atoms or to break chemical bonds. The photons in ionizing radiation do. They contain enough energy to damage the insides of a cell by disrupting the delicate cellular proteins.

To measure the amount of ionizing radiation, medical physicists place a small device, called an “ion chamber,” in the beam of x-rays. The ion chamber captures the photons from the beam. Medical physicists can’t count photons directly but they can measure the amount of charged particles the photons create. The amount of charge in the ion chamber gives them an estimate of how much ionizing radiation gets to the target.

Moving the patient and the beam
Once the medical physicists set up the radiation equipment to produce the beam they want, it’s easier to move people into and out of that beam. In stereotactic radiosurgery and in standard radiation treatment, that’s what they do — carefully.

Directing an ionizing x-ray beam through someone’s body will kill all the cells in the beam’s path, healthy or cancerous. So, medical physicists calculate a set of arcs in three dimensions that share a common area: the tumor. The beam passes through the patient’s body along the paths the arcs describe. Tumor cells receive the most radiation because every arc goes through the tumor. Healthy cells along each arc get much less radiation because only one arc passes through them. They can recover.

To make sure the x-ray beam follows the arcs exactly, medical physicists calculate how to move the patient. The treatment couch, on which the patient lies, allows the physics team to rotate the patient horizontally. The gantry head on the radiation machine rotates vertically. Using the gantry head and
treatment couch together, the physics team can create an infinite number of arcs through a patient’s body.

To keep the patient perfectly still during treatment, the physics team uses custom fitted frames. They use a metal stereotactic head frame secured to patient’s skull for stereotactic brain surgery. They use a metal mesh cage fitted over the face for radiation treatment to the head and neck, including hippocampal-sparing treatment. And they use a custom-fitted foam bed for radiation to the body. Following the arcs precisely ensures that the patient’s important body structures, like the optic nerve, receive as little radiation as possible.

One beam, many procedures to fight cancer
For stereotactic radiosurgery, the medical physicists must calculate the set of arcs after the patient is fitted with the metal head frame. The head frame provides unmovable reference points for brain structures, so it’s critical for such a precise procedure. But it also means that the patient must be fitted with the head frame first and then wear the head frame while the arcs are calculated. Ms. Ward wore her head frame for several hours while Mr. Calderon and the medical physics team completed the calculations and all equipment checks. Future stereotactic radiosurgery patients may not need to wait as long.

Ms. Ward’s stereotactic radiosurgery was successful. When her medical team reviewed her brain scans, they were pleased to find that the tumor was gone. But they found another fast-growing tumor in the other side of her brain. So Ms. Ward and her medical team had to make a decision. Ms. Ward could have chosen to undergo another stereotactic radiosurgery procedure to kill the new tumor but the procedure kills only one tumor at a time. She would face more radiosurgery procedures if any other fast-growing tumors that the scan couldn’t show lurked. Some patients and their doctors decide to use repeated radiosurgery procedures. Ms. Ward elected to have a hippocampal-sparing radiation treatment instead.

The hippocampal-sparing procedure drenches the entire brain, except the hippocampi, with radiation over several weeks. Each hippocampus sits on either side of the brain stem at the base of the brain and looks surprisingly like a seahorse. They are critical for forming memories. People with damaged hippocampi are unable form any new long term memories. They are not able recognize people they just met, cannot learn new words or songs, cannot negotiate a path through a city, and cannot even remember their last birthday.

Recently-released data from the Radiation Therapy Oncology Group showed that sparing the hippocampi in radiation therapy preserved memory-making ability. People receiving hippocampal-sparing procedures had no memory loss compared with those who had received whole-brain radiation therapy. Thomas Schroeder, MD, prescribed the hippocampal-sparing procedure combined with a tumor-focused treatment for Ms. Ward. The procedure kills the new tumor and also any new tumors taking root in her brain that are too small to see on a scan. The UNM Cancer medical physics team calculated the best possible treatment beams to converge on the new tumor and to go through the whole
brain without ever passing through either hippocampi. “Computers are a great help,” says Mr. Calderon.

The treatment isn’t over yet, but the medical team and Ms. Ward are hopeful. The treatments are easy enough on Ms. Ward that she’s able to drive herself from her Santa Fe home to her appointments in Albuquerque. For now, that’s a great achievement by itself.
Thomas Schroeder, MD, is an Associate Professor and Head of the Section of Radiation Oncology in the Department of Internal Medicine, Division of Hematology/Oncology, at the University of New Mexico School of Medicine. He is also the Medical Director of Radiation Oncology at the UNM Cancer Center.

Donna Siergiej, PhD, is Director of Medical Physics at the UNM Cancer Center.

Eder Calderon, MS, DABR is a Medical Physicist at the UNM Cancer Center.

The Radiation Therapy Oncology Group (RTOG) is a national clinical cooperative group funded by the National Cancer Institute (NCI) since 1968 to increase the survival and improve the quality of life of patients diagnosed with cancer. Learn more at: [http://www.rtog.org/](http://www.rtog.org/).

**About the UNM Cancer Center**
The UNM Cancer Center is the Official Cancer Center of New Mexico and the only National Cancer Institute-designated Cancer Center in the state. One of just 68 premier NCI-Designated Cancer Centers nationwide, the UNM Cancer Center is recognized for its scientific excellence, contributions to cancer research, the delivery of high quality, state of the art cancer diagnosis and treatment to all New Mexicans, and its community outreach programs statewide. Annual federal and private funding of over $77 million supports the UNM Cancer Center’s research programs. The UNM Cancer Center treats more than 60 percent of the adults and virtually all of the children in New Mexico affected by cancer, from every county in the state. It is home to New Mexico’s largest team of board-certified oncology physicians and research scientists, representing every cancer specialty and hailing from prestigious institutions such as M.D. Anderson Cancer Center, Johns Hopkins University, and the Mayo Clinic. Through its partnership with Memorial Medical Center in Las Cruces, the UNM Cancer Center brings world-class cancer care to the southern part of the state; its collaborative clinical programs in Santa Fe and Farmington serve northern New Mexico and it is developing new collaborative programs in Alamogordo and in Roswell/Carlsbad. The UNM Cancer Center also supports several community outreach programs to make cancer screening, diagnosis and treatment available to every New Mexican. Learn more at [www.cancer.unm.edu](http://www.cancer.unm.edu).

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