Precision Cancer Treatment at Eisenhower

Stereotactic Radiosurgery and Radiotherapy

Left to right: Philip Shaver, MD; Alfred Shen, MD, Monica Khanna, MD, and Farhad M. Limonadi, MD

The Eisenhower Lucy Curci Cancer Center is the only facility in the Coachella Valley to offer Stereotactic Radiosurgery – computerguided radiation that aims highly focused beams of radiation directly into a tumor.

Although radiosurgery has been in existence since 1951, the use of ionizing radiation in the treatment of cancer has evolved dramatically since its first inception. Today, stereotactic radiosurgery is an important and viable alternative to invasive surgery and is used to treat a variety of cancers, including cancers of the brain and spine.

In addition to cancerous and benign tumors, radiosurgery is also used to treat arteriovenous malformations, a tangle of expanded blood vessels that disrupts normal blood flow in the brain, and other abnormalities of the brain.

Recently, Healthy Living magazine assembled three prominent professionals from Eisenhower Medical Center,well-versed in the use of stereotactic radiosurgery and radiotherapy to discuss this cuttingedge treatment technique: its benefits, challenges and technological advances. The panel included Monica Khanna, MD, a Board Certified Radiation Oncologist; and Board Certified Neurosurgeons Farhad M. Limonadi, MD, and Alfred Shen, MD. The panel was moderated by Philip Shaver, MD, a Board Certified Cardiologist with Eisenhower Medical Center.

DR. SHAVER: We talk about radiotherapy and radiosurgery. Dr. Limonadi, our readers may not know what exactly we mean by putting the word “radio” in front of “surgery” or “therapy.”

DR. LIMONADI: Radiotherapy or radiation therapy is defined as a treatment of disease with ionizing radiation. Essentially, it uses high energy rays to damage cancer cells, and stop them from growing and dividing.A specialist, such as Dr. Khanna, using radiation treatment for cancers, is called a radiation oncologist. Like surgery, radiotherapy is a local treatment of the disease and is meant to affect the cancer cells only in the treated area.

DR. SHAVER: Dr. Khanna, we’ve had radiation around for a long time.What’s different about this radiation therapy that we offer now at the Eisenhower Lucy Curci Cancer Center?

DR. KHANNA: The advances in neuroimaging and planning software that we now have, as well as the linear accelerators that exist today allow us to deliver very precise beams of radiation, essentially targeting only the tissues we want to irradiate and sparing normal tissues. There is gamma knife radiation, proton beam, as well as linear accelerator-based stereotactic radiation or radiosurgery – the difference is the source of radiation that is being utilized, but the outcome is the same. The goal is to have a very defined target with those treatments. The gamma knife uses cobalt and the proton unit uses a proton particle. Linear accelerator-based radiation therapy is the most common form, and uses a photon beam.

DR. SHAVER: How do you single out the cancer cell and not wipe out everything between the source of the beam and the cancer cell?

DR. KHANNA: Through careful planning, we can minimize exposure to normal tissue. The radiation therapy actually works by causing DNA damage in the tumor cell, thus destroying it over time. Normal, healthy tissues will also experience DNA damage, but over time, they can repair that damage.Tumor cells do not have the ability to repair DNA damage.

DR. SHAVER: Is there any risk of irradiating the tumor one day, and creating a cancer by this same therapeutic maneuver at a later date?

DR. LIMONADI: Do radiation treatments cause cancer? It can; however, the process of treatment planning is a multi-disciplinary task involving neurosurgeons, radiation oncologists, medical oncologists, and involves integration of physical findings, diagnostic imaging data, knowledge of pertinent anatomy, pathology, and natural history of the disease. The goal of such a complex approach is to offer patients the safest treatment approach, surgical, radiation, or a combined approach, and minimize the probability of complications.

DR. SHAVER: Dr. Shen, let me try to get a historical prospective. In medical school, I can recall as a junior medical student assisting on surgery to remove a brain tumor, which turned out to be a 12-hour surgery. Fast forward to now – from this very long, tedious procedure that I think probably did a lot of damage to normal tissue – how would that be approached by this therapy now?

DR. SHEN: It is dependent on where the tumor is located, what structure it is adjacent to and what previous surgeries have been done on that tumor. If the tumor is in an accessible location, surgery is still the primary treatment for it. After treating it with surgery, if there is still residual tumor, one can treat that remaining tumor with either radiation therapy or stereotactic radiosurgery. DR. SHAVER:: Explain what you mean by “stereotactic.”

DR. SHEN: Stereotactic radiosurgery is a term that was coined by Swedish neurosurgeon Dr. Lars Leksell in 1951 when he tried to describe the ability to focus multiple external beams of radiation to a defined target in the brain. Since that time, there have been various advances in stereotactic radiosurgery.

DR. LIMONADI: Stereotactic means defining the precise location of the target in three dimensional space and directing the tip of a fine surgical instrument or beam of radiation to it using radiographic image guidance. DR. SHAVER:: What is the difference between stereotactic radiosurgery versus stereotactic radiation therapy?

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—Monica Khanna, MD

DR. KHANNA: Radiosurgery would be a single “fraction,” or a single treatment, versus stereotactic radiation therapy, which is multiple doses of radiation, again a very defined beam of radiation delivered in more than one fraction.

DR. SHAVER: But why fractionate?

DR. LIMONADI: With fractionation, you divide up the total doses of radiation in several sessions. In doing so, theoretically, you increase the total lethal dose to the tumor cells and lower it for normal cells while allowing them to repair themselves. DR. SHAVER:: Is there an advantage to using gamma rays or linear accelerators?

DR. SHEN: There are very small differences between the two. A gamma knife has smaller spatial resolution and uses cobalt which needs to be replaced periodically, and therefore, is more costly than a linear accelerator. In addition, the gamma knife uses multiple isocenters (areas of focused radiation) to target non-spherical lesions, which may lead to hot spots in one area of the tumor.

DR. KHANNA: The advantage for linear accelerator-based radiosurgery is that we can actually shape the beam.We’re not limited by the shape of the tumor.With a gamma knife you’re limited by spherical dose points.

DR. SHEN: Brain tumors are not, unfortunately, purely spherical. In combining the round fields to conform to the tumor, we end up with overlapping circles. The area that overlaps will get a little bit more radiation than other areas. The software that we now have with linear accelerators, allows us to more accurately shape the beam to the tumor.

DR. LIMONADI: It’s important to note that the radiation beam preferentially damages proliferating cells, which are very radiosensitive at certain phases of the cell cycle. Normal tissues and tumors that are rapidly proliferating are more likely to be irradiated at the radiosensitive phase of the cell cycle. Normal cells in the brain and spinal cord are either static or slowly dividing.Tumor cells, however, rapidly reproduce and are typically in high proliferative phases, and so are affected by radiation treatments significantly more than normal brain tissue.

DR. SHAVER: How precise is stereotactic radiosurgery?

DR. KHANNA: Right now, we have a precision of within three millimeters to shape the beam, and that is a threedimensional shaped beam. Two years ago, state-of-the-art precision was five millimeters, and unbelievably, five years ago it was 10 millimeters. DR. SHAVER:: Are there any robotic techniques that you use in this?

DR. LIMONADI: We employ robotic techniques right here.The conformality of the beam is managed by robotic manipulaters.

DR. KHANNA: One point that I think needs to come through in all of this is that we immobilize the patient to get a precise reproducible target from imaging.We plan so that the treatment, the beam, is delivered to the area we want, within a few millimeters of accuracy. Once the patient has been immobilized, we can then use our robotics to help guide the patient into the exact treatment position.

DR. SHAVER: With central nervous system lesions or brain tumors, how do you decide to perform surgery and/or stereotactic radiosurgery?

DR. SHEN: It depends on the accessibility, size, patient age, and the general health of the patient. For most central nervous system lesions, whether they're tumors or mass lesions, surgery is still considered the primary treatment. There is now growing evidence that in some instances, you can treat some masses primarily with stereotactic radiosurgery though.

DR. LIMONADI: Surgery is the single modality of treatment of brain cancer that has been shown to render patients with the longest disease-free survival, and highest quality of life. The role of with the longest disease-free survival, and highest quality of life.The role of the surgery is, number one, to reduce the number of cells which is referred to as cytoreduction. Two, to provide a specimen so that we can gauge what combination of treatment modalities we are going to use. Three, to re-oxygenate the tissue. It has been shown that tumors that have outgrown their oxygen supply require three times as much radiation as the tissue that is well-oxygenated. By removing the tumor, or the bulk of the tumor, in fact, we oxygenate that tissue, which will then require significantly less radiation. Number four and most importantly, to reduce the mass effect of the tumor, which is often the primary reason for the brain or spinal cord tumor causing neurological problems and/or death. After we have diminished the size of the tumors that cannot be entirely removed, we can treat the rest with highly precise stereotactic radiosurgery. This combined approach improves outcomes significantly.

DR. SHAVER: What does the future hold for stereotactic radiosurgery in the treatment of cancers in other locations?

DR. KHANNA: The goal is ultimately to deliver stereotactic radiation therapy to other areas of the body. Again, the first concern will be immobilization, and then to be able to reproduce the area of treatment from the imaging.This is still a work in progress, but the spine is definitely the easier target. Soft tissues move with respiration and become harder to isolate. I am sure that in the next few years, there will be software that allows for the movement of respiration, and will allow us to target the tumors in other areas.

DR. SHAVER: So, the best application remains the central nervous system, because it moves the least.

DR. KHANNA: The central nervous system and the spine.