A new technology called MRI-guided radiation therapy allows tumors to be visualized in real-time during treatment. In what has been called “a world’s first,” physicians at Siteman Cancer Center at Barnes-Jewish Hospital and Washington University School of Medicine in St. Louis began treating patients with this new therapy in January 2014.

The ability to focus treatment to specific areas has improved as radiation therapy has evolved. Twenty years ago, for example, alignment was done using a combination of skin marks and plain film x-rays. More recently, cone beam CT has been used for alignment. Although cone beam CT is useful for localization for many radiation treatments, what has lagged, says Dr. Jeffrey Olsen, assistant professor of radiation oncology at Washington University School of Medicine, has been the ability to have confidence in soft-tissue target localization of the radiation target and where the critical structures are.

“While cone beam CT is great for alignment based on bony anatomy or structures that are well visualized on a CT, it’s not ideal for alignment based on soft tissue anatomy,” he says. “MRI allows much better visualization of soft tissue anatomy, so for a long time the question has been, would it be possible to use an MRI, which provides better soft tissue localization, for patient alignment? There have been many limitations from a technical standpoint of how to integrate an MRI machine with a traditional linear accelerator.”

ViewRay’s system has a split bore magnet—like a double-donut magnet—and in between is a ring gantry where there are three cobalt sources, which deliver the radiation. The radiation is shaped using a multi-leaf collimator, so each source has the ability to shape the beams to do IMRT, SBRT or CRT. The ViewRay installation at the Siteman Cancer Center couples a cobalt-60 treatment device with a 0.35-Tesla magnet, enabling one to use MRI for localization, as well as re-planning at the time of treatment. In situations where localization or patient alignment using either plain x-rays or a cone beam CT are challenging, MRI can be used for soft tissue localization of either the tumor, the target itself, or normal structures without exposing the patient to additional radiation.

“With radiation oncology, it’s important to know exactly where the tumor is. We use a lower field strength magnet that minimizes distortions to the image and the beam, so that we can accurately deliver the dose. In essence, we took two proven and compatible technologies—a low field strength magnet and cobalt—and modernized them to build a system that is comparable to the current standard in dose delivery and one that offers phenomenal soft tissue imaging before and during the radiation treatments.”

ViewRay treatments are recorded so patients can monitor and share their progress. © 2014 ViewRay Inc.
As Dr. Olsen explains, from a patient treatment standpoint, the treatments themselves are very similar, except that a patient would come in and undergo an MRI each day, which is different from a workflow standpoint compared to a diagnostic MRI.

“The patient undergoes daily MRI, and that MRI is used for alignment just like in the past we’ve used plain film x-rays or CT imaging for alignment,” he says. “Based on what one sees on MRI, we can evaluate the change in anatomy or change in dose distribution and then decide if the current plan is sufficient or if a re-plan is necessary. The component of re-planning or so-called adaptive planning is something that has never been done before in radiation therapy. We are working to implement adaptive planning clinically based on changes in MRI, and we should be able to implement true adaptive therapy in the coming months.”

Dr. Olsen says that when the system was first installed at Siteman, they only had access to the imaging component. They had opened clinical trials to evaluate which situations are best suited to this type of treatment. Now that they can use the machine for treatment, they have a good sense of what are the patient situations where one’s likely to have the greatest benefit from MRI-guided radiation therapy.

There are two different components to ViewRay’s system: 1) using MRI for localization, that is, being able to use an MR for soft tissue alignment to visualize tumors better; and 2) adaptive planning, having the ability to modify a plan based on a change in tumor appearance or size, or other characteristics (such as normal tissues that are moving in or out of the radiation field over the course of treatment).

“If a tumor shrinks, shrinking the radiation field is something that historically has not been done, so it represents a change from how we’ve previously treated certain types of cancers. These modifications to treatment potentially allow increased dose to the tumor, or reduced dose to normal tissue. Since this is a new workflow for radiation oncology, we are carefully implementing these changes, generally under an institutional clinical trial,” Dr. Olsen says.

Saracen says ViewRay’s system also speeds up treatment planning. “We can do a full Monte Carlo Treatment Plan in under two minutes. A standard calculation for Monte Carlo for most other systems takes anywhere from 15 to 20 minutes. ViewRay provides the ability to change a treatment plan while the patient is on the table, giving clinicians the opportunity to modify and personalize treatments day-to-day if need be.”

MRI-guided radiation therapy contributes to personalized medicine by targeting radiation treatment and decreasing the amount of normal tissue that is being irradiated. There’s greater confidence in exactly where the tumor is, thereby allowing greater precision in localization. Also, adaptive radiotherapy would allow one to have a treatment plan tailored very much to a patient’s specific situation such as when the tumor is changing in size, or as it responds to treatment, or if critical structures (normal tissues that are sensitive to radiation) move into the treatment field.

Thirty-four patients have been treated so far at Siteman. The first two patients were lung cancer patients, ages 67 and 80. As for how many patients they will treat per year, Dr. Olsen says the number of potential candidates may grow as they learn more about tumor motion and discover emerging applications. Tumors in the pelvis, in the abdomen, or tumors in other locations where there’s a great deal of motion (e.g., a lung tumor) are strong candidates for MRI-guided radiation therapy.
“I would envision MRI-guided radiation therapy as a useful tool in specific patient situations. The technique is unlikely to entirely replace current treatment techniques, although as we learn more about the specific situations where MRI guidance is most helpful, we will likely see increasing applications,” Dr. Olsen says.

“We gave our first patient an iPad with all of his treatments on it. He had had cancer several years ago, and then got another tumor treated with ViewRay,” Saracen says. “During treatment he said, ‘You know? I was always scared, but looking at my treatment, being able to see what you did, it’s amazing the confidence it gave me that you’re doing the right thing.’ I think that was touching and telling.”

“We’re offering not only the physician, but the patient, the ability to say, ‘This is what happened, and this is your movie. This is what’s going on.’”

ViewRay’s system, which sells for $8.5 million, is also being installed at the University of Wisconsin at Madison and at UCLA in California. Both centers plan to treat their first patients this summer.

Saracen says the company is currently in seven different markets and has six clients, some of which are international. He says the system has the potential to be used on the same patient population as a standard Linac treating with photons, and that ViewRay’s system “could one day truly be a replacement for the standard linear accelerator.” With IMRT, image guidance, 3D conformal radiation therapy and SBRT, all the current billing codes could be used.

Saracen says ViewRay has strong financial backing with some of the top investors in the medical device space. He points out that the first three centers using the system are world-class cancer centers, with renowned physicians working with the system. Furthermore, the company’s scientific advisory board includes five past presidents of ASTRO, six ASTRO gold medal winners and 3 AAPM current/past presidents.

“These are the top people in the industry who truly believe that this is the next generation of where things are going,” Saracen says.

“I think it’s an exciting time to be able to offer this new type of treatment. With any new technology, when you’re the first to implement it, you want to be careful and methodical, and I think we’ve done that,” Dr. Olsen says. “We are making sure that we’re cautious about reporting outcomes appropriately and determining the situations where there’s likely to be the greatest benefit, and in which situations traditional radiation therapy is the most appropriate. So far, implementation of the treatment technique has been very promising.”

References


ROSEMARY RITCHIE: ALMOST A HALF-CENTURY OF SERVICE

At the end of March, Rosemary Ritchie retired after 47 years working in radiation oncology. By any measure that’s an impressive achievement, yet Rosemary’s modest about her years of service. This is her story.

“I’ll miss the people, patients and co-workers,” Rosemary says regarding what she will miss and has most enjoyed. “The people I’ve worked with, being in a profession that is always changing that required you to be constantly thinking and keep abreast with current information, and being in the company of others who are doing the same thing. I have enjoyed delivering health care, being able to help someone who is having a serious healthcare issue, and being part of their recovery or their support.”

Rosemary began her career in x-ray training in a hospital-based program. One year in, she completed what she calls a “rotation”—it was very loose in those days, she says,