

STEREOTACTIC RADIO THERAPY

THE NEXT STEP IN PRECISION



Cancer survivor **Linda Holland** with her treatment team at Emory University (left to right): radiation therapist **Tony Webb**; chief medical physicist **Timothy Fox, PhD**; and **Ian Crocker, MD**.

New stereotactic treatment technologies represent significant progress toward turning cancer into a manageable condition.

Cutting-edge radiation oncology departments are pioneering ultraprecise stereotactic radiation treatment and bringing new hope of eradicating previously unreachable tumors. How? With a new breed of medical linear accelerator, specialized accessories, and techniques adapted from brain radiosurgery. This new dimension in radiation oncology makes it possible to think seriously about transforming cancer from a fatal disease into a manageable condition.

In October 2004, a 56-year-old woman became the first person treated with image-guided radiosurgery using Varian's new Trilogy™ machine, an ultraprecise, high-powered linear accelerator with an On-Board Imager™ accessory. A 10-year survivor of lung cancer, the woman underwent radiosurgery for two small metastases in the brain. The single procedure delivered a cancer-killing radiation beam so powerful and tightly focused that it was called *radiosurgery* instead of radiation therapy. The patient was back at work within two days.

Had she been treated a month earlier, this patient would have received low-dose radiation to her entire brain, with less probability of eradicating the cancer. "Given her favorable long-term outlook, we were committed to delivering a focal high-dose radiation treatment to eliminate the risk of brain injury from radiation treatment to the whole brain," explains Ian Crocker, MD, professor of radiation oncology at the Emory University School of Medicine in Atlanta, Georgia.

Varian's Trilogy machine is the first medical linear accelerator optimized for stereotactic treatments.

The case at Emory is just one of many examples of stereotactic treatments that take advantage of recent advances in imaging, precision beam delivery, treatment planning, and automated patient-positioning technologies.

In standard forms of external beam radiation therapy, the patient receives the radiation dose in small daily increments over a period of weeks. By contrast, stereotactic radiation treatment delivers very high radiation doses in a short course of only a few days—or even a single session. Recent studies have suggested this strategy can be more effective at killing or controlling certain types of cancer.

Delivering higher radiation doses safely, however, requires a higher standard of precision in targeting the beam to the tumor shape and exact location. Varian's Trilogy machine is the first medical linear accelerator optimized for stereotactic treatments.

It has a more tightly focused beam and can deliver doses more than 60 percent faster than conventional accelerators to reduce the effects of tumor motion, shorten treatment times, and enhance patient comfort. It can be equipped with a highly maneuverable On-Board Imager accessory with radiographic, fluoroscopic, and cone-beam CT scanning capability for image-guided patient positioning.

The precision of stereotactic radiotherapy promises exciting new options for patients, enabling radiation treatment at earlier stages when cancer is most curable, making many inoperable tumors treatable, and providing a noninvasive alternative to surgery.



Radiotherapy Control Console

ADVANCED TREATMENT FOR MORE PATIENTS

A young mother is one of 90,000 people worldwide who develop spinal tumors each year. In her case, the location of the tumor near the spinal cord makes surgery and standard external beam radiation treatment too dangerous.

The University of Texas M.D. Anderson Cancer Center in Houston is one of the few treatment centers where doctors offer stereotactic spine radiotherapy using a modified linear accelerator. A CT scanner in the treatment room is used to scan the patients and ensure they are positioned precisely for treatment. "Almost every type of cancer can spread to the spine, so there is a great clinical need for the procedure," explains Eric Chang, MD, director of the Stereotactic Spine Radiotherapy Program. "However, it isn't widely available because it is so complicated to perform."

Varian's Trilogy accelerator, which combines treatment delivery and imaging in a single system, represents a significant step toward making this kind of treatment easier to deliver. "With the CT imaging that is available on Trilogy, we hope to cut treatment time from the two hours it takes today to 30 minutes," says Chang. "This advance may make stereotactic spinal radiotherapy available in more centers."



“Using the Trilogy system, we have the potential to substantially improve cancer treatment outcomes.”

Lawrence Davis, MD, Emory University

INOPERABLE LUNG CANCER IN THE CROSSHAIRS

Surgery can be an effective treatment for early-stage non-small cell lung cancer, which strikes more than a million people worldwide each year. But surgery is out of the question for a dearly loved grandfather because he also has advanced emphysema.

Stereotactic radiotherapy can be an alternative for cancer patients like this man, who have other ailments that preclude surgery. The standard radiation treatment for inoperable lung tumors takes 30 daily sessions. Researchers at the Indiana University School of Medicine theorized that a higher dose delivered over just three sessions might be more effective and less dangerous for frail patients.

According to Robert D. Timmerman, MD, formerly of Indiana University and now at University of Texas Southwestern in Dallas, the Indiana clinical team was able to safely escalate the dose to levels they thought would improve on tumor control rates. Without the benefit of a Trilogy machine or an On-Board Imager device, they managed by immobilizing patients in a stereotactic body frame and using a conventional linear accelerator. A machine like Trilogy, with its On-Board Imager device, would have been extremely helpful, Timmerman says.

“An On-Board Imager accessory allows you to see, on the fly, what you’re aiming at,” he says. “We try hard to be accurate, but there is always uncertainty that the target is where you think it is. On-board imaging adds to your confidence that you are aiming correctly, so you can limit the safety margins. It might allow treatment of a smaller volume.”

Early evidence from Indiana points toward good local tumor control with few side effects. Now a group study based on this work is taking place in the United States at dozens of hospitals and clinics. Timmerman, principal investigator for the study, expects stereotactic radiotherapy techniques to advance quickly with the number of multi-institutional studies under way, including one in Germany on liver metastases and another in Japan on lung tumors.

The Kyoto University Graduate School of Medicine is one of 16 leading institutes in Japan participating in a three-year study involving 165 lung cancer patients. “If this study demonstrates that stereotactic radiation treatment can be a standard of care for inoperable non-small cell lung cancer, it will be good news,” says Yasushi Nagata, MD, PhD, Department of Therapeutic Radiology and Oncology. Because it is noninvasive, stereotactic radiation treatment could eventually become a preferred option for patients with operable tumors as well.

ZEROING IN ON MULTIPLE METASTASES

A woman with non-small cell lung cancer has several metastases in her liver. Three cycles of chemotherapy, the standard treatment, have had little effect.

Patients like this woman are not normally treated with radiation once their cancer spreads, but investigators at the University of Chicago in Illinois are trying something new. They are backing up chemotherapy with pinpoint stereotactic radiotherapy to small metastatic tumors in up to five sites anywhere in the body.

“By treating each small metastatic tumor with a very high dose over a few sessions, we hope to shrink or completely eradicate the tumors,” says Mary Martel, PhD, associate professor of radiation oncology.

With Trilogy, doctors may for the first time have a practical means of routinely treating tiny metastatic lesions where cancer has spread. Using new imaging processes such as PET/CT scans in post-treatment checkups, clinics may be able to detect these lesions and then eradicate them with image-guided stereotactic treatments. Thus, cancer could be turned into a chronic disease managed through a series of checkups and treatments when metastatic lesions reappear.

Varian introduced Trilogy at the beginning of 2004 and, by the end of September, had 27 orders for the new machine and several installations—a relatively fast adoption rate for a new technology in radiation oncology. The first Trilogy unit was installed at Emory University. “Using the Trilogy system, we have the potential to substantially improve cancer treatment outcomes,” says Lawrence Davis, MD, chairman of the Department of Radiation Oncology at Emory.

Visionaries see tremendous potential in the combination of new imaging capabilities and more precise tools for radio-surgery. “Imaging technologies are being developed that will eventually give us the same information for diagnosis and treatment that we get from surgical biopsy today,” predicts Emory’s Ian Crocker. “If we could make a diagnosis of lung cancer, for example, based on imaging information alone, we are certainly developing the tools to remove the tumors radiosurgically.”

In the meantime, the promise of stereotactic therapy is beginning to pick up speed. ●