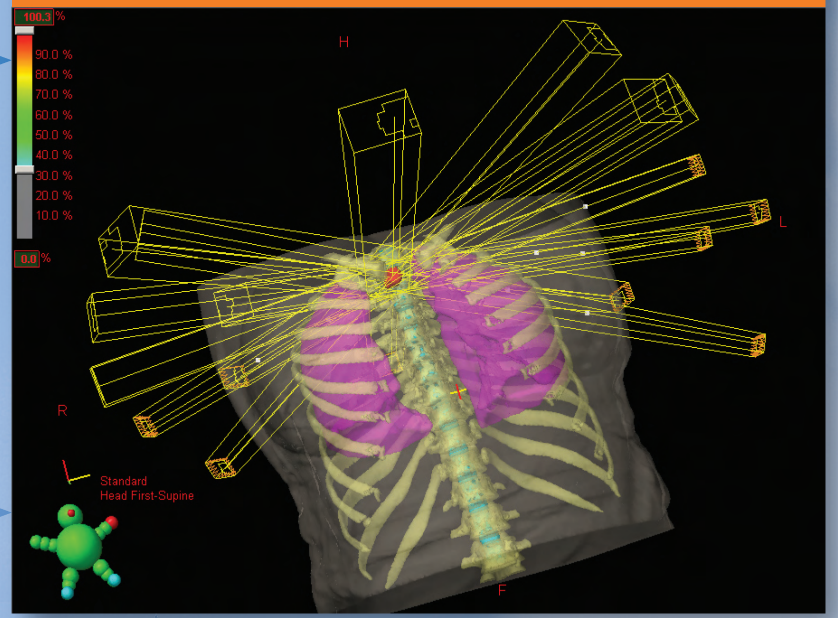
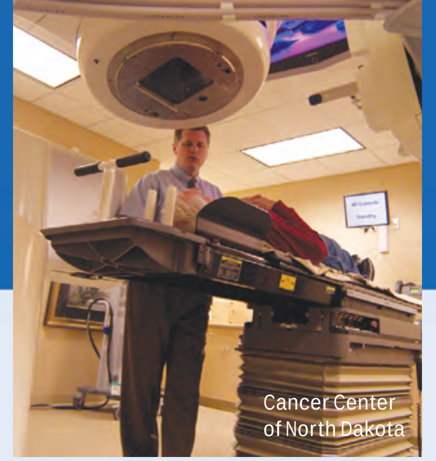
THE DYNAMIC TARGETING® IGRT ADVANTAGE

Verify, Analyze Treatment Plan, Correct and Treat



Varian Advantage –
4 Distinct IGRT Capabilities Targeting Cancer

VARIAN
medical systems



IGRT at a Rural, Freestanding Cancer Center

by William R. Noyes, MD

Late last year, the Cancer Center of North Dakota purchased Varian Medical Systems' On-Board Imager, an automated system for IGRT. By offering new technology, such as IGRT, our freestanding cancer center ensures that North Dakota residents can access the latest treatment modalities without having to travel out of state.

The On-Board Imager At-a-Glance

The On-Board Imager is mounted on the treatment machine (linear accelerator) and uses robotically controlled arms that operate along three axis of motion. The arms can be positioned optimally for the best possible view of the tumor—all without ever having to move the patient. Any adjustments to the patient's position can be carried out by a radiation technician from outside of the treatment room.

An amorphous silicon flat-panel X-ray image detector yields high resolution X-ray digital images showing internal anatomic landmarks with a high degree of precision. Images are taken to pinpoint tumor site, adjust patient positioning, and complete the treatment in a standard treatment time slot.

The On-Board Imager allows radiographic, fluoroscopic, and 3D cone-beam CT images to be swiftly acquired at the time of treatment. The treatment appointment lasts an average of 10 to 15 minutes, and is administered over a period of time based on each specific patient's needs.

In addition, the technology incorporates an RPM™ respiratory gating system that monitors and compensates for tumor motion during the radiation treatment. In other words, if the patient breathes deeply during the radiation treatment and the tumor moves out of the pre-set guidelines, the radiation beam shuts itself off.

Key Strategies

✔ First understand the clinical variation and qualitative differences in various radiation therapy applications.
✔ Know the total cost of ownership, including physical plant construction for housing the technology, staff training, and costs related to total package integration with your existing infrastructure.
✔ Consider using a single or limited number of vendors to allow for trust and relationship building and for easier integration of technology and data flow.
✔ Understand the clinical ramifications of not investing in certain technologies and the effect this decision may have on patient care.
✔ Budget for future system upgrades to maintain current treatment approaches and to support any future treatment changes.
✔ Understand that the technology's full potential will be reached only when you have fully trained dosimetrists, physicists, and therapists on staff.
✔ Connect with other cancer centers that use the technology and ask questions to ensure the right decision is being made.
✔ Collaborate with a local hospital so patients may take advantage of the full benefits found at a freestanding cancer center, including having access to both radiation and chemotherapy services in one location, having the latest technologies, having medical and radiation oncologists working side-by-side, and having ease of entrance to a single building.

Improving Treatment

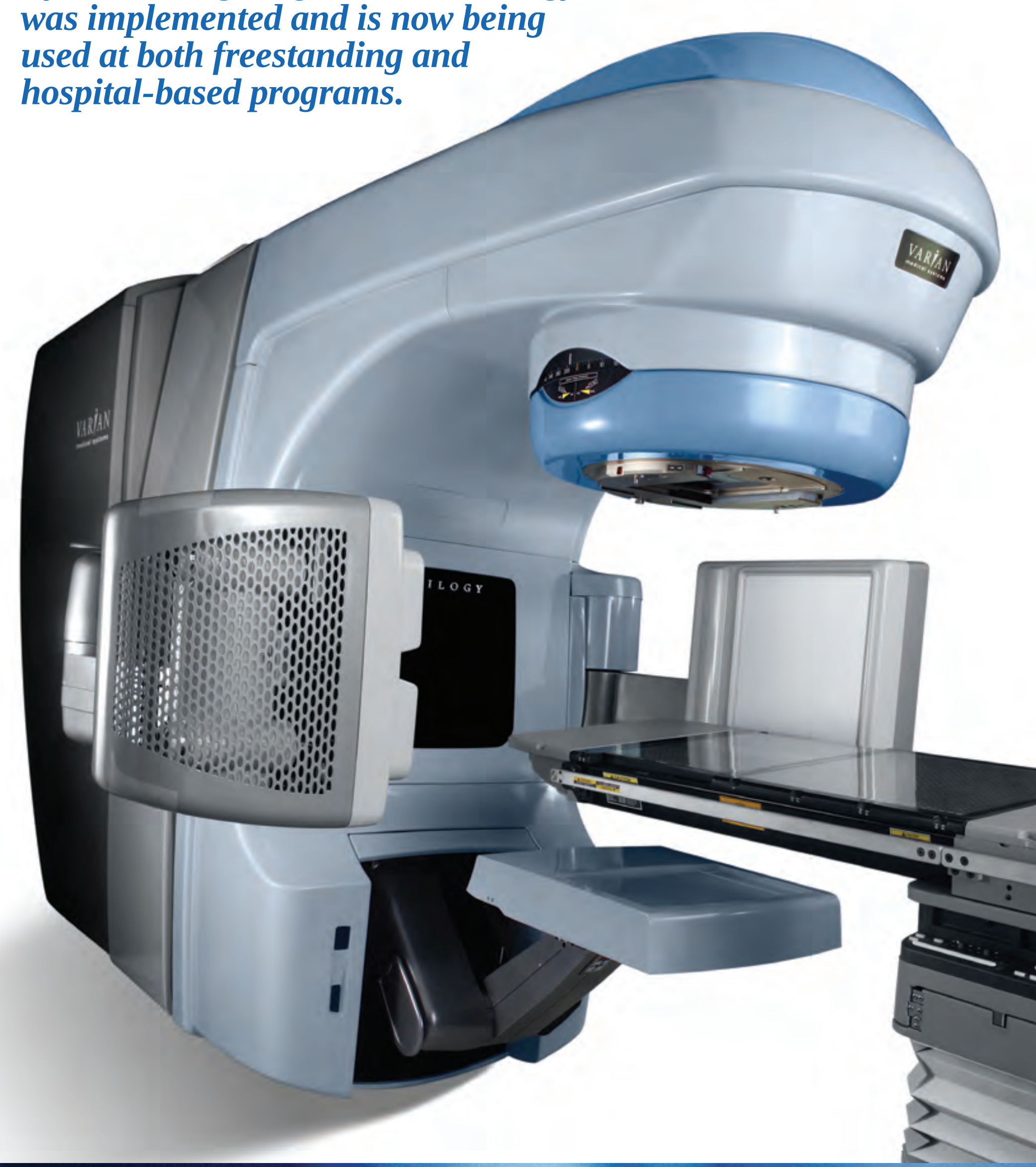
IGRT has greatly improved our ability to treat malignant tumors. Before acquiring this technology, we developed treatment plans based on CT information possibly taken several days before the radiation treatment. Since tumor position can change daily, this treatment scenario was not optimal. In addition, we had to rely on external skin markers using laser systems, and the patient had to be physically repositioned several times for X-rays to ensure treatment was accurate. Even after all of these steps were performed, radiation treatment still affected a relatively large margin of healthy tissue. Today, IGRT allows us to pinpoint the tumor location to within half a millimeter, which means we treat the tumor—not the healthy tissue.

Because we are a small, freestanding center and do not have the financial resources that a larger, hospital-based cancer program may have, the decision to invest in new technology was not made lightly. The considerations were many, but the benefits provided by IGRT clearly justified the financial, programmatic, and staff resources involved in the venture. The return on investment: better treatment within a shorter window of time with fewer side effects and better outcomes.

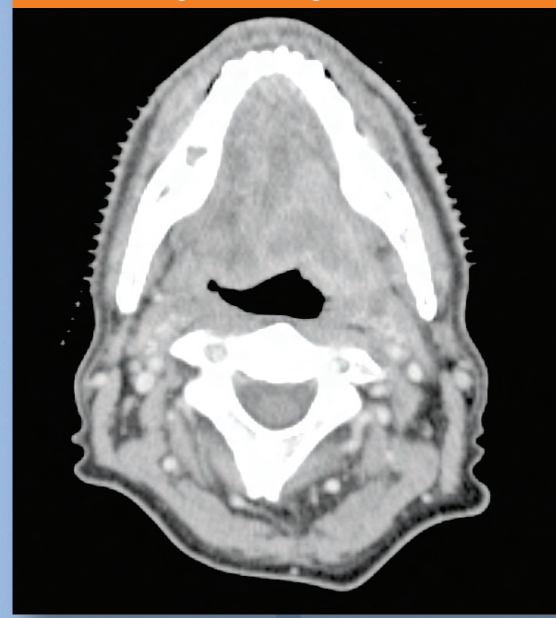
IGRT in the Community

As a treatment process, image-guided radiation therapy has been in use for several decades. In recent years, as a result of advances in computer technology hardware and software applications, IGRT technology has reached new levels of sophistication.

What follows is a brief look at how Varian's Dynamic Targeting IGRT technology was implemented and is now being used at both freestanding and hospital-based programs.

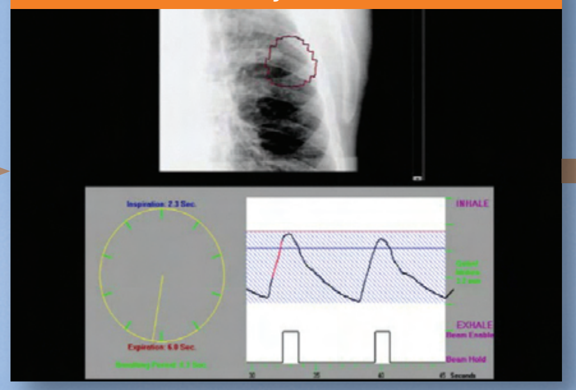


Diagnostic Image Data Set



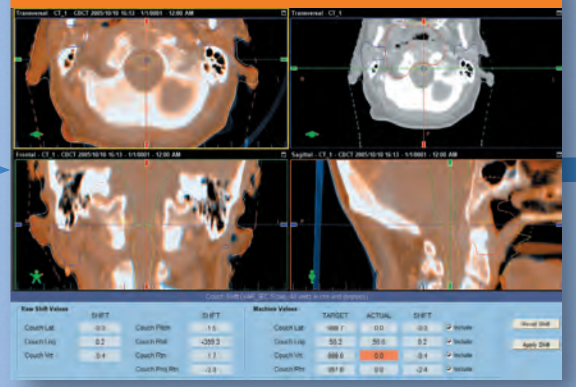
1

Tumor Motion Analysis Before Treatment



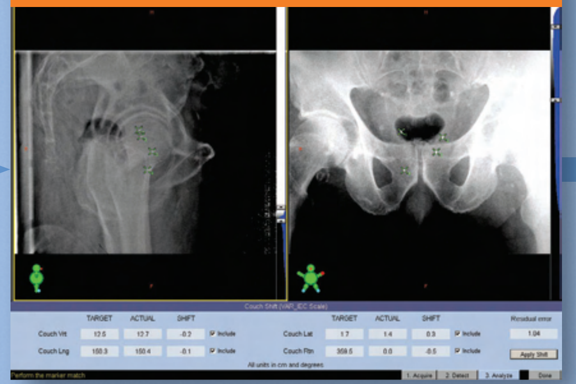
2

3D – CBCT Dataset



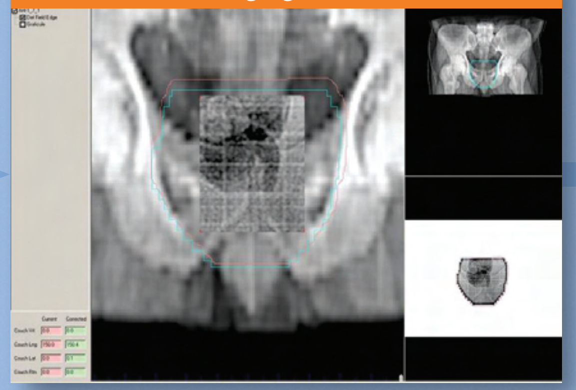
3

2D – Orthogonal kV-kV Image Pair



4

2D – MV Imaging for Localization



IGRT at an NCI-designated Comprehensive Cancer Center

by Arno J. Mundt, MD; Todd Pawlicki, PhD; Kevin T. Murphy, MD; and Michael S. Goldman, FACHE

The Rebecca and John Moores Cancer Center, University of California, San Diego, opened a new 270,000-square-foot facility in 2005. Clinical services, including MRI, digital imaging, and radiation oncology, and basic clinical, translational, and cancer prevention research are now housed in one location. The cancer center has approximately 70,000 patient visits per year. In 2005, the Department of Radiation Oncology at the University of California, San Diego acquired a Trilogy® System, and since that time has been implementing leading-edge IGRT solutions.

Partnering with a single IGRT vendor for planning, delivery, and database needs has brought some programmatic benefits. IGRT involves not just sophisticated hardware but a significant software infrastructure. An integrated clinical information system provides clean integration of data. If hardware or software issues arise, we go to one company to troubleshoot the problem. With a single platform on a single database, our department can interface with other systems within our hospital.

Our radiation oncology department phased in use of the new IGRT technology in incremental steps. The program first began with planar imaging on our new accelerator to visualize the bony anatomy of the patient on the treatment table and to realign the patient to match the position of the CT simulation. With the Trilogy System, patient set up for planar IGRT is straightforward and optimized because the system allows online corrections. The system includes automatic tools for anatomy matching and table repositioning. The kV images are captured via robotic arms that support an opposed kV X-ray source and flat panel image. Image quality of kV images is superior to MV imaging. The system can capture these images every day for every single fraction. Kilo-voltage imaging allows the patient to receive a lower dose for each image and at the same time allows for better localization of the anatomy.

Step 1. Localize tumors directly rather than the bony anatomy using the new technology. We began by doing daily prostate localization using planar imaging based on fiducial localization. Patients are positioned on the table and imaged with planar imaging. The seeds (fiducial markers) are matched by a therapist and the table translated remotely to move the patient into the correct position.

Step 2. Phase in use of cone-beam CT features. The capability of reconstructing images and making 3D pictures from a CT scan provides much more information than that provided by bony anatomy or seed-implanted fiducials. Using this technology, patients can be imaged and positioned daily before each treatment. A benefit from cone-beam CT is that the patient can be positioned directly based on the position of the tumor rather than tumor surrogates such as bony anatomy or fiducials. Future patient benefits will include the potential to modify treatment volumes and decrease acute toxicities.

We believe that the new IGRT technology of the Trilogy System provides a major advance in the treatment of brain tumors in that it offers continuous real-time tracking using optical guidance. An infra-red camera detects typical movements of the patient, making it possible to monitor the patient in real-time throughout the entire course of treatment. If there are any patient movements "outside tolerance levels," the treatment will be stopped and the patient re-positioned.

Step 3. The Varian RPM™ Respiratory Gating System. As part of the gating program, with the kV imaging system, it is possible to use fluoroscopy to observe a lung tumor or fiducial movement in real-time. We can now watch the patient breathing, and verify our understanding of the patient's breathing pattern and its relationship to tumor motion. We treat only during a short period of the breathing cycle. Hypofractionated protocols for lung cancer are possible due to the ability to shrink target volumes and, hopefully, allow dose escalation.

IGRT technology, which is allowing better targeting, may make it possible to re-irradiate patients that previously would not have been considered candidates for re-treatment. For example, with spine tumors, sometimes it is possible to re-treat recurrent metastases in the spine with IGRT and IMRT.

Looking to the future, we have a strong interest in broadening the use of IGRT for image-guidance. On the horizon is DART™ Dynamic Adaptive Radiation Therapy, which will usher in a new paradigm for the treatment of cancer with radiation.

Practical Tips

Identify a clinical champion. Adopting new technology requires change, and someone needs to lead the process of change. A clinical champion can help foster buy-in so that the entire multidisciplinary team feels comfortable with the move forward.

Begin with education. Plan for education of all staff that will be involved in implementing the new technology, including physicians, therapists, dosimetrists, and physicists. For radiation therapists, IGRT presents significant work process changes and an increased knowledge of anatomy that may require specific in-service training.

Start slowly. Plan for a phased-in, step-by-step implementation process. The Cancer Center at UCSD integrated the new technology by beginning with planar imaging and then moving to volumetric imaging, respiratory gating, and optically-guided treatment.

Understand documentation and billing. Currently, IMRT and IGRT allow for improvements in treatment delivery and planning along with improvements in the hospital's bottom line. Hospitals that are going to invest in this costly technology will need to see improvements in billing and reimbursement, and they do with IMRT and IGRT.

The Rebecca and John Moores Cancer Center, University of California, San Diego

Growing an IGRT Program at a Community Cancer Center

by Michael Greenberg, MD

The Dale and Frances Hughes Cancer Center in East Stroudsburg, Pa., is part of the Pocono Health System. Our Cancer Center began providing IMRT treatment in January 2000. In October 2004, the program added a second linear accelerator equipped with Varian's On-Board Imager and 3D cone-beam CT technology.

Today, we use 4D treatment plans, which enable us to account for the motion of the organ as well as patient motion. We are using respiratory gating to treat limited field breast cancer and lung cancer. During the initial simulation, we perform a 4D perspective gated scan. If the target moves, then we will go ahead and implement a gated beam. The beam gates to the respiratory cycle. So when the target is out of the field, the beam shuts off; when it's in the field, it turns on. We have the benefits of being able to track the target motion and have the beam turn on and off automatically with the respiratory cycle.

IGRT allows re-treatments in areas that could not be re-treated previously.

The technology also makes it possible to deliver high doses of radiation to areas like the prostate without seeing any morbidity, where previously the risks of rectal bleeding, for example, were much higher.

Our program implemented IGRT in stages. In April 2005, we began with kV imaging, adding cone-beam CT the summer of 2005, and finally Varian's RPM respiratory gating system shortly thereafter. Implementation of the new IGRT technology required both work process adjustment and staff in-service training. We addressed the training process as a team with myself, our physicist Louis Nardella, and our dosimetrist Francine Sheridan.

Once our technologists were comfortable with kV imaging, they moved on to cone-beam CT. Initially, the program's radiation oncologist spent more time reviewing the images while our radiation technicians became more adept with the newer technology. Because this type of imaging is a paradigm switch from the type of imaging and patient set up with which RTTs are traditionally trained to work, we provided in-service training for staff RTTs on anatomy and on how to review the cone-beam CT images.

Today, patients receiving IGRT represent about 75 percent of our center's radiation oncology patients. We treat about 45 to 50 patients a day. Leading cancer sites being treated with IGRT at the program are prostate, brain, and pelvic and intra-abdominal malignancies.

IGRT: Staff and Patient Benefits

by James McGee, MD, and Roger Crawford

OSF Saint Francis Medical Center in Peoria, Ill., is the primary hospital providing tertiary-level radiation oncology services for 31 rural counties. Because one-third of our patients come from more than 30 miles away, we often employ modalities that can be delivered with a minimal number of trips for the patients, including radiosurgery and brachytherapy. Our radiosurgery program began in 1991, with a Linac couch-mounted system for brain radiosurgery, and was enhanced in 2001 with the addition of a Gamma Knife®. Two factors drove the decision to incorporate image-guided radiation therapy (IGRT) with X-ray imaging:

1. The necessity to optimize and further develop our current treatment methods
2. The need to greatly refine conventionally fractionated treatment regimens.

While fractionation would remain critically important for some patients, others would benefit from hypo-fractionated or single fraction treatment regimens. For all patients, rapid treatment set-up and delivery remained critically important.

Just as Gamma Knife radiosurgery had transformed the way we treat a variety of CNS lesions, we believed that the accuracy and precision of IGRT would "transform" our ability to treat tumors at other body sites. We also strongly believed that the IGRT system we selected would need to be very flexible, since no one can predict the future of radiation oncology practice with any degree of certainty.

We began treating patients with IGRT in August 2005.

Benefits

Not only has the On-Board Imager vastly improved our ability to "see" what we are doing during daily treatments, we are learning new lessons about patient set-up daily. For example, if image alignment is not certain because of bowel or stomach position changes, we do not treat. Instead, we explain to the patient that the purpose of this new technology is to avoid less-than-optimal treatment delivery.

Making treatment set-up more comfortable for the patient, more reproducible on a daily basis, and clearer for evaluation has become a passion for our staff. As a consequence, more thought is going into the simulation process, and staff members are more excited by their jobs.

Even more important, our cancer patients are greatly benefiting from this new technology. Our prostate patients now receive significantly higher doses to the prostate, and have far fewer rectal problems than in the past. Patients who previously would not have been treated by radiation have excellent results from hypofractionated, non-invasive treatment for primary lung cancers and metastatic liver lesions. Most remarkably, patients with severe pain from spine metastases are reporting great pain relief within one day after radiosurgery for spine lesions.

Implementation

The decision was made to implement our new treatment-planning system well ahead of the new treatment machine so that we would not be starting all systems at the same time. One benefit to this approach was that many of the interfaces that came later had a sense of familiarity. We also began treatment implementation incrementally, starting first with prostate patients with fiducial markers using 2D orthogonal image-matching, then adding 3D cone-beam CT, and then gradually over three months adding spinal radiosurgery cases that routinely required 2D and 3D imaging. After staff reached a comfort level with these modalities, we added respiratory gating to begin treatment with hypofractionation for primary lung cancers, solitary liver lesions, and upper abdominal lesions that were seen to move on respiratory-gated CT simulation.

One key factor in our successful implementation process was having a lead radiation therapist who had mastered the technology present for all treatments. Another important step: one radiation oncologist and one medical physicist were given primary charge for oversight of all IGRT treatments on the new machine.

Standard protocols, often from the Radiation Therapy Oncology Group (RTOG), were used to minimize confusion relative to patient-treatment processes. Keeping treatment approaches congruous by site and type helped a staff that was already coping with a large amount of new equipment that arrived at one time.

Image-guided radiation therapy has become, for us, a mind's-eye view of how the radiation is delivered, and we—both staff and patients—are far better for it.

OSF Saint Francis Medical Center in Peoria, Ill.

Our Purchasing Decision

For IGRT, treatment planning, delivery, and quality-assurance all involve processes that are dependent on the easy movement of images over a variety of systems. We found the on-board imaging system of Varian's Trilogy System to be an intuitive process that mitigated the need for fiducial marker placements, which were increasingly problematic and unreliable as the indications for IGRT expanded.

In order to reduce operator-dependent set-up variability, the ability to use X-ray imaging by conventional 2D kV and 3D cone-beam CT imaging was also a must.

In the end, we felt that an integrated single-vendor solution would be preferable to a "best-of-breed" or multi-vendor solution as it eliminates conflicts in operations and service.