

Dynamic Targeting™ Image-guided Radiation Therapy – A Revolution in Cancer Care

a report by

Varian Medical Systems

With the development of intensity-modulated radiation therapy (IMRT) during the mid to late 1990s, radiation therapy entered a new era. IMRT gave doctors the ability to deliver exquisitely shaped doses that closely conform to the dimensions of a tumor. The state-of-the-art in the field progressed from using radiation beams like flashlights to narrowly focused ones like lasers.

Seeing the Extent of Disease

The ability to shape dose distributions very precisely resulted in a number of new challenges. Firstly, it became much more important to be able to ‘see’ the extent of disease more clearly, leading to a revolution in oncologic imaging. Many radiation oncology departments acquired dedicated computed tomography (CT) scanners, and later began using positron emission tomography (PET) and other biological and functional imaging modalities to fine-tune treatment planning for radiotherapy.

Nevertheless, when aiming a narrowly focused beam at a tumor, clinicians need to know exactly where it is every moment during treatment, or they risk missing the target.

Interfraction and Intrafraction Motion – IGRT and Dynamic Targeting

Tumors are not stationary. They move between and during daily treatments. They are subject to ‘interfraction’ motion due to unavoidable day-to-day variations in anatomy or in how patients are positioned for treatment. And they are subject to ‘intrafraction’ motion, due to respiration and other physiological processes.

To deal with ‘interfraction’ motion, radiation therapy is embracing a strategy called image-guided radiation therapy (IGRT). IGRT tools enable clinicians to image a tumor just prior to treatment and to adjust for set-up errors or changes in tumor position. They include technologies like the On-Board Imager™ device from Varian Medical Systems, a kilovoltage X-ray imaging system that is mounted on the radiotherapy treatment machine or linear accelerator. The On-Board Imager provides high-resolution radiographic, fluoroscopic, and cone-beam CT images of the tumor just before and

during treatment. Varian’s SonArray™ system is another IGRT technology that uses ultrasound imaging for daily prostate localization. And the company’s RPM™ Respiratory Gating system can be used to synchronize imaging and dose delivery with a patient’s breathing cycle.

These and other Dynamic Targeting™ IGRT technologies enable doctors to plan and compensate for tumor motion in realtime.

Stereotactic Strategies in Radiation Oncology

Because Dynamic Targeting IGRT improves precision, it also raises the possibility of reducing the 30 to 40 daily treatment sessions or ‘fractions’ normally needed for delivering a total dose of radiation. With improved imaging and delivery technology, some small lesions could be treated in a single session with ‘stereotactic radiosurgery’. Others could be treated in as few as three to five sessions with ‘hypofractionated radiotherapy.’

In the past, stereotactic approaches were not widely used for treating many extracranial tumors due to tumor motion issues and set-up uncertainties. With the added precision afforded by Dynamic Targeting IGRT methods, stereotactic approaches for more disease sites are becoming feasible. Consequently, in 2004, Varian introduced the Trilogy™ linear accelerator, which is optimized for delivering stereotactic radiotherapy and stereotactic radiosurgery, as well as the full spectrum of radiotherapies, from conventional and 3-D conformal to SmartBeam™ IMRT and Dynamic Targeting IGRT.

An Explosion of Data and Images

All of these developments have led to an explosion of digital data and images that must be managed and made useful for every step of the process, from imaging to planning, simulating, verifying, and delivering treatments. To meet this challenge, Varian developed the Inspiration™ environment, a seamlessly integrated network of radiation oncology tools. At the heart of Inspiration is VARiS Vision™, a comprehensive software program that links all clinical operations and



patient information through a single, powerful, relational database, configured to keep information current in all parts of the treatment process. In 2004, Varian added several new clinical management tools to the VARiS Vision™ software, so that it now provides a complete electronic health record. All the components of the Varian Inspiration environment are engineered to work together intuitively, facilitating clinical workflow patterns so that patients can be treated with the most appropriate and advanced therapy within the normal 15-minute appointment.

Inspiration builds a solid foundation for the innovations coming in the future. The state-of-the-art in radiation

therapy is moving quickly in the direction of ever-increasing precision. That is good news for cancer patients who need radiation therapy. ■

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