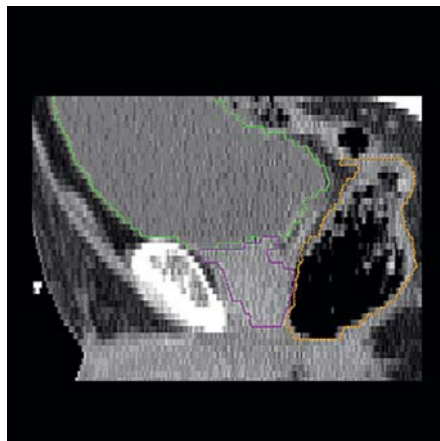
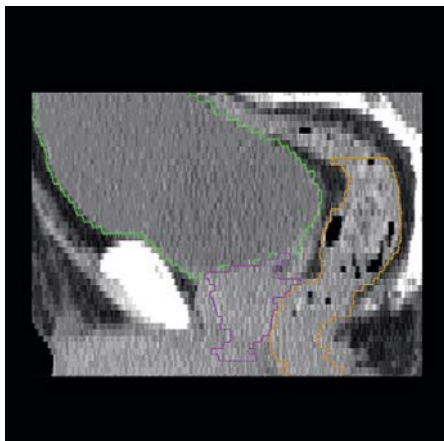


Precision Meets Efficiency in Radiation Oncology

The latest development in Adaptive Radiation Therapy, Siemens' IM-RealART Solution, allows clinicians to efficiently and precisely adjust treatment planning during a treatment fraction, fast and without repositioning the patient.

By Sameh Fahmy, MS



Significant deviations between the original planning CT (on the left) and the interfractional acquired CT (on the right) due to changes in organ shape, as shown here, are countered quickly and precisely with IM-RealART.

“We are moving to an era where we can design and deliver more individualized treatment, tailored to not just the patient’s geometry and anatomy, but also biology.”

X. Allen Li, PhD, Chief of Physics, Professor, Medical College of Wisconsin and Froedtert Memorial Lutheran Hospital, Milwaukee, Wisconsin, USA

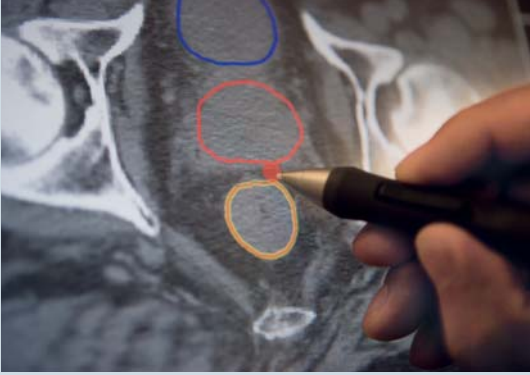
The term Adaptive Radiation Therapy (ART) has been used for more than a decade to describe various methods that use imaging to increase the precision of radiation therapy, but its true potential is just now being realized in routine clinical use. X. Allen Li, PhD, Chief of Physics and Professor at the Medical College of Wisconsin and Froedtert Memorial Lutheran Hospital in Milwaukee, Wisconsin, USA, notes that, in the past, the term was often used to describe adjustments to treatment plans to account for systematic anatomic changes and/or to treatment table position in order to compensate for interfractional changes in tumor location. But conventional technologies cannot rapidly compensate for changes in tumor shape that can occur randomly during the course of treatment or the rotation that occurs in regions such as the head and neck and the prostate. With Siemens’ new IM-RealART™ Solution, however, Li and his colleagues can adjust treatment plans to compensate for both systematic and random changes in tumor location, shape, and rotation while maintaining an efficient workflow. “By adopting the IM-RealART Solution from Siemens, we’re able to treat patients more efficiently and more precisely,” Li says. “That may offer them better care because of potentially increased local control and/or reduced toxicity.”

The IM-RealART Solution combines the CTVision™ System, Siemens’ unique computed tomography (CT) scanner on rails, with the Prowess Panther RealART Treatment Planning System. CTVision provides imaging with the highest resolution and quality directly in the treatment vault, making it the gold standard imaging solution. Optimized for Siemens’ linear accelerator ARTISTE™ Solution, the IM-RealART Solution allows clinicians to rapidly take an interfractional CT scan of a patient, to adapt to significant changes in tumor, and to create a new treatment plan in around seven minutes – without the need for patient repositioning.

A Changing Target

Li has been evaluating Siemens’ IM-RealART for the past two years through retrospective patient analysis and has quantified significant changes in tumor location, shape, and rotation. In prostate cancer, standard Image-Guided Radiation Therapy (IGRT) can adjust for changes in tumor location that occur as the prostate shifts in response to volume changes in the bladder or rectum. However, Li points out that changes in tumor shape and rotation can also be significant, and not compensating for those changes can result in unnecessary radiation exposure to healthy tissue and decreased dose to the tumor. “Without the adaptive

approach, we would be treating patients with uncertainties that in some situations can be quite large,” he says. Changes in tumor location, shape, and rotation are assessed by measuring the percent volume overlap between the planning CT image and the interfractional CT. An organ overlap of 100 percent indicates that no shape changes occurred, while lower levels indicate more severe changes. Li says that based on the preliminary data from his group, a percent tumor overlap of 85 percent or less in the prostate necessitates replanning. He has also found that severe variations in prostate shape and rotation occur in nearly one-third (31 percent) of treatment fractions. The IM-RealART Solution allows the radiation oncology team to adapt rapidly to such changes. As the patient is lying on the treatment table, the CT on rails acquires a new image in as little as one minute. Li points out that CTVision is a critical component of the IM-RealART



Considerable changes in tumor shape and rotation can lead to unnecessary radiation exposure, which must be accounted for in treatment.

Solution, since superb image quality and soft-tissue contrast that clearly define the target and nearby critical structures are prerequisites for precise dose delivery. Next, the new, interfractional CT scan is compared with the planning CT image or a former interfractional CT scan, and the percent tumor overlap is assessed. If the change to tumor shape and rotation is negligible, the treatment proceeds as planned. If the tumor has changed significantly, rapid replanning using the Prowess Panther RealART Planning System begins.

In a process that takes approximately seven minutes, the clinician delineates the new tumor and critical structure contours using a drawing tablet and pen. The software then morphs the aperture and optimizes the segment weights. With the click of the "export" button, the new multileaf collimator (MLC) apertures are transferred to the linear accelerator and treatment delivery can start.

"The key to this technology is its ability to generate the plan rapidly," Li says. "Conventionally, we would need at least half an hour to generate a plan. Now, we can do it in a few minutes."

Workflow, Patient Benefits

Li says that the IM-RealART Solution provides workflow benefits even in the two-thirds of patients in which there are no significant shape or rotation changes. He explains that tumor location changes were previously accounted for by mov-

ing the treatment table. He notes that in addition to requiring the technician to enter the treatment vault, repositioning the treatment table introduces the potential for human error. With the IM-RealART Solution, tumor location shifts can be accounted for through MLC changes, saving time and easing workflow. He points out that in roughly the same or slightly longer time required to deliver IGRT, which only compensates for location changes, he can now generate and deliver a new treatment plan that compensates for location, shape, and rotation.

The IM-RealART Solution also improves the patient's treatment experience by keeping the CT scanner and the linear accelerator in the same room and eliminating the patient's need to relocate. Li says that when patients know they are being treated with a state-of-the-art system that reduces exposure to healthy tissue, they gain a sense of confidence in what is undoubtedly a challenging time for them.

At the Medical College of Wisconsin and Froedtert Hospital, the IM-RealART Solution is currently being used for prostate tumors, but Li and his colleagues are already planning to assess its potential in the treatment of breast tumors. He says that preliminary data suggest that shape changes in breast tumors can be dramatic, making this an ideal site for the RealART Solution. Head and neck tumors, in which rotational changes can also be significant, as well as abdominal tumors are other

sites where the technology could be particularly well suited, he says.

IM-Confident Plan for fast IMRT

The ability to replan treatment of patients on the spot with the IM-RealART Solution can be combined with the IM-Confident™ Plan, Siemens' solution for fast Intensity-Modulated Radiation Therapy (IMRT). IM-Confident combines intelligent planning software with Siemens' fast and precise 160 MLC™ Multileaf Collimator, which has a small, five-millimeter leaf thickness to provide better conformity to the tumor shape and a high leaf speed of up to four centimeters per second. It is a standard component of the ARTISTE linear accelerator, but is also available as an upgrade on the ONCOR™ accelerator. "Conventionally, it would take about 12 to 15 minutes to deliver IMRT," Li says. "Now with the IM-Confident Plan, delivery time can be cut down to five minutes with the ARTISTE accelerator or the ONCOR 160 MLC accelerator."

The rapid delivery of IMRT that IM-Confident enables has clear workflow benefits, Li says. It can allow the radiation oncology department to treat an additional two or three patients per day by shortening treatment scheduling blocks from 30 minutes per patient to 25 minutes per patient. Shorter treatment times also have the potential to reduce treatment uncertainties, Li points out, since the longer patients are on the treatment table, the more likely they are to fidget and move.



Dr. Li and his colleagues are now able to treat patients more efficiently and precisely with IM-RealART, including CTVision.

Summary

Challenge:

- Compensating for changes in tumor location, shape, and rotation that can occur between treatment fractions
- Easing workflow and improving patient experience
- Delivering fast IMRT with precision

Solution:

- Siemens' IM-RealART Solution, optimized for the ARTISTE linear accelerator, combines CTVision with the Prowess Panther RealART Treatment Planning Software to make the delivery of ART precise and efficient
- The CTVision system places a CT scanner on rails in the same room as the linear accelerator with a gold-standard image quality, eliminating the need for the patient to relocate
- Siemens' IM-Confident Plan combines intelligent treatment planning software with Siemens' 160 MLC, standard on the ARTISTE accelerator and as an upgrade on the ONCOR solution

Result:

- Treatment plans can be adapted to interfractional changes in tumor shape, location, and rotation in around seven minutes, increasing the dose to the tumor and decreasing the dose to healthy tissue
- Workflow is streamlined and patient inconvenience is minimized
- IM-Confident delivers fast and precise IMRT possibly in five minutes or less in a clinical routine for all treatment sites

Part of Li's excitement about Siemens' IM-RealART and IM-Confident Solutions are the possibilities they create for dramatically improving the quality of care that patients receive. "This opens the door for several innovations," Li says. "For example, because we are able to treat the patient more precisely with this technology, we should be able to reduce treatment margins. With reduced treatment margins, we can further increase the dose to the tumor to allow us to increase local control or reduce the dose to normal structures and reduce toxicity."

Another exciting option that the increased precision of IM-RealART enables is hypofractionation, which is delivering a course of treatment in fewer fractions. Instead of a treatment course consisting of 44 fractions, for example, treatment has the potential to be safely delivered in as little as five or six fractions. Put another way, a course of treatment that would otherwise take two months has the potential to be completed in two weeks. The cost savings could be substantial, Li notes, and patients would experience significantly less disruption in their daily lives.

And while today's ART is concerned primarily with anatomical changes, Li says that personalized radiation therapy based on biological data acquired through imaging is clearly on the horizon. "We are moving to an era where we can design and deliver more individualized treatment, tailored to not just the patient's geome-

try and anatomy, but also biology," he says, noting that functional and physiological magnetic resonance imaging (MRI) and positron emission tomography (PET) can be used to assess the sensitivity of tumors to radiation treatment.

Li and his colleagues are currently planning two clinical trials that will assess the impact of ART on improving patient outcomes. The first is to explore the use of small margin to improve healthy tissue sparing, thus reducing treatment side effects. The second is a treatment fraction reduction trial in which Li and his colleagues plan to investigate reducing the number of treatment fractions to improve patient quality of life and reduce costs.

"We always want to provide the highest standard of care possible to our patients in terms of technology, treatment, and medicine," says Li, "Together with Siemens we're constantly working toward that goal."

Sameh Fahmy, is an award-winning freelance medical and technology journalist based in Athens, Georgia, USA.

Further Information

www.siemens.com/radiation-oncology