Revving up the treatment process with onsite simulation, planning, and treatment (OSPT)

Kevin Choe, M.D., (left) and Arnold Pompos, Ph.D., implemented the protocol that drastically reduces patient waiting time on the first visit.
Radiation therapy has historically been a multistep process, involving a consultation, a CT simulation scan, and a waiting period while dosimetrists and physicians design a plan, and finally, plan verification and treatment. Patients typically wait about a week to receive their first treatment.

But a new process developed at UT Southwestern Radiation Oncology has recently demonstrated this waiting time can be shrunk to just a few minutes, primarily by automating some processes. And the department has recently launched an ambitious program to begin treating certain patients within about 30 minutes of their first consultation here.

“We want to change the paradigm of how we treat patients,” says Assistant Professor and medical physicist Arnold Pompos, Ph.D., who co-led the initiative internally. “In the future, the whole experience will be dramatically different. We will no longer send patients home from their consultation in a state of uncertainty about when their treatment is going to begin.”

The new workflow process has been dubbed “onsite simulation, planning, and treatment (OSP)”, meaning that patients remain in place, lying on the treatment table, while physicians and physicists quickly perform real-time treatment planning and delivery.

Rather than go to a separate CT room for imaging, the patient is set up on a treatment machine with onboard cone beam CT imaging capability. Images are automatically exported to a program that auto-contours the outlines of the area to be treated, which takes about one minute. Another auto-planning program then creates an optimal treatment plan for the delivery of radiation—about five minutes. Doctors and physicists improve, modify, and verify the plan rather than develop one from scratch.

OSP was implemented for the first time this summer with a handful of patients needing whole-brain radiation for the treatment of brain metastases. Whole-brain radiation was selected as the pilot site for OSP because of the relative simplicity of planning.

All treatments so far have taken place on the department’s Elekta Agility linear accelerator. Anh Le, Ph.D., a recent addition to the department’s faculty, created a software option that modified the Agility’s traditional cone beam CT acquisition to acquire primary imaging for planning purposes.

“When we brought up this new paradigm, it turned out the system had the potential to fulfill this need in the hands of an expert—such as Dr. Le—who knows what to do,” says Dr. Pompos.

“Currently, we are trying to set up similar tools on other machines and talking to vendors about how to make this a seamless, fully automated process from cone beam acquisition to the moment of radiation delivery.”

Auto-planning is accomplished using vendor-supplied software, although current tools are somewhat limited. There are future plans to incorporate the department’s own GPU-based planning research into the process, based on the pioneering work of Medical Physics and Engineering Division Chief Steve Jiang, Ph.D., who has led the industry’s emerging use of GPU processors for radiation planning calculations. Vendors are also striving to provide improved auto-planning software.

The OSP process currently takes an average of 37 minutes from the time the patient enters the treatment room until he or she exits. The unique context of OSP requires all members of the team—attending physicians, physicists, therapists, and dosimetrists—to work closely and at the same time to quickly modify, approve, and implement the plan.

“It’s a collective approach that requires everyone to work together like gears in a well-oiled machine,” Dr. Pompos says. “The better we understand the details of each step and how the individual pieces fit together in the workflow, the more we’re able to reduce the time of each step.”

In the future, the department plans to expand OSP to more disease sites with more complicated plans, such as those for lung cancer and prostate cancer. For now, most whole-brain patients here will continue receiving the expedited treatment.

The OSP process was initiated by Department Chairman Hak Choy, M.D., and spurred by the planning of a new radiation treatment facility at UT Southwestern. With that facility in mind, faculty members have been challenged to reassess and, in some cases, reinvent old processes based on newer technology.

“We are always striving to give the best treatment to the patient in the most convenient way,” says Kevin Choe, M.D., Ph.D., Assistant Professor of Radiation Oncology and a specialist in treating brain cancer. “If we can minimize traveling back and forth for multiple appointments and also minimize wait time using this expedited method, we think it will result in an improved patient experience.”

Dr. Pompos agrees. “People who need cancer treatment don’t want to leave empty-handed after their first appointment, thinking ‘why are they sending me home?’” he says. “For the patient, this is going to alleviate potential anxiety about that gap in treatment time. For radiation oncology professionals, more uniform processes mean less possibility for error.”

 Whole brain plan for actual patient using OSP protocol. Planning target volume is in pink.
KRAS gene mutation inhibitor found

Radiation oncologist Kenneth Westover, M.D., Ph.D. recently was awarded a $900,000/3-year grant from the Cancer Prevention and Research Institute of Texas (CPRIT) to study structure-guided kinase inhibitor design for cancer therapy. The award follows closely on the publication of Westover lab findings of a selective inhibitor of the KRAS gene mutation.

The molecule, SML-8-73-1 (SML), interferes with the KRAS gene, or Kirsten rat sarcoma viral oncogene homolog. The gene produces proteins called K-Ras that regulate cell division and help repair DNA. Mutations in the KRAS gene produce proteins that block repair enzymes and turn cancerous.

Learn more about the KRAS gene mutation inhibitor found by Kenneth Westover, M.D., Ph.D., and his research team.

Blocking DNA repair for glioblastoma

Department researchers led by Sandeep Burma, Ph.D., have demonstrated both in vitro and in mice that blocking critical DNA repair mechanisms could improve the effectiveness of radiation therapy for glioblastomas. Radiation therapy causes double-strand breaks in DNA that must be repaired for tumors to keep growing.

Joining our 12-person radiation oncology trainee group are:

- Dan Ishihara, M.D., Ph.D.—graduate of Albert Einstein College of Medicine
- Steven Lau, M.D., Ph.D.—graduate of University of Cambridge and University of California, San Diego
- Vasu Tumati, M.D.—graduate of New York Medical College

Our newest medical physics trainees are:

- Matthew Webster, Ph.D.—graduate of University of California, San Diego

Scientists have long theorized that if they could find a way to block repairs from being made, they could prevent tumors from growing or at least slow down the growth, thereby extending patients’ survival. Blocking DNA repair is a particularly attractive strategy for treating glioblastomas because these tumors are highly resistant to radiation therapy. In a study, UT Southwestern researchers demonstrated that the theory actually works in the context of glioblastomas.

“This work is informative because the findings show that blocking the repair of DNA double-strand breaks could be a viable option for improving radiation therapy of glioblastomas,” says Dr. Burma, Associate Professor of Radiation Oncology in the Division of Molecular Radiation Biology at UT Southwestern.

Researchers in the Burma lab found that enzymes called cyclin-dependent kinases (CDKs) involved in cell division activate homologous recombination (HR) by phosphorylating a key protein, EXO1. In this manner, the use of HR is coupled to the cell division cycle, which has important implications for cancer therapeutics.

These findings were published April 7 in Nature Communications.

Brachytherapy expert joins Radiation Oncology, helps launch intraoperative program

Assistant Professor Michael Folkert, M.D., Ph.D., has been recruited to UT Southwestern Radiation Oncology to spearhead the launch of a comprehensive intraoperative brachytherapy practice within the department.

“Intraoperative radiation therapy will allow us to directly treat tumor beds that are exposed during surgery,” says Dr. Folkert. “We can completely circumvent the need to go through healthy tissue to reach the target.”

Dr. Folkert originally studied nuclear engineering at the Massachusetts Institute of Technology (MIT) and earned his Ph.D. in radiological sciences through the Harvard-MIT Division of Health and Technology. He began his career in medical physics at the Massachusetts General Hospital, but his close work with radiation oncologists there soon turned his interest to medicine.

He later earned a medical degree at Harvard Medical School and then completed his residency in radiation oncology at Memorial Sloan Kettering Cancer Center, where he pursued a specific interest in brachytherapy research, publishing numerous papers and helping develop devices, protocols, and techniques to deliver brachytherapy treatment to spine, esophageal, and rectal lesions.

At UT Southwestern, Dr. Folkert is initially working with the Department of Ophthalmology to offer brachytherapy eye plaque treatment for patients with intraocular tumors.

With this treatment, rice-sized “seeds” of radioactive iodine-125 are placed into a thin gold shield, which is attached to the back of the patient’s eye through a surgical procedure. After about three days, when the full dose (70-85 Gy) is delivered, the eye plaque is removed.

Dr. Yuguang He, M.D., Associate Professor of Ophthalmology, will initially examine patients and refer them to Dr. Folkert to discuss options for radiation treatment. After the radiation team creates a plan for radiation delivery and assembles the plaque, the two physicians will together verify the location of the tumor in the operating room, and Dr. He will perform the surgery to attach the eye plaque device.

Brachytherapy is preferred for the eye over standard external beam treatment in many cases because it can minimize toxicity while preserving the patient’s vision.

Intraoperative brachytherapy for many other sites, including head and neck, abdominal, and pelvic tumors will soon become possible when shielding is completed in one of the operating rooms of the new William P. Clements Jr. University Hospital, which opened in November.

“Intraoperative brachytherapy may improve local control, particularly for gastrointestinal tumors and recurrent head and neck tumors,” says Dr. Folkert. “With this technique we can hope to curatively treat even patients with locally advanced cancers requiring extensive surgery, and patients who have had their disease return after prior external beam radiation therapy.”

Department welcomes new trainees

Radiation Oncology was pleased this summer to welcome our newest residents in radiation oncology and medical physics, all highly qualified trainees who joined our program after an extremely competitive selection process.

- Luo Ouyang, Ph.D.—graduate of UT Southwestern Graduate School of Biomedical Sciences
- Dan Ishihara, M.D., Ph.D.—graduate of Albert Einstein College of Medicine
- Steven Lau, M.D., Ph.D.—graduate of University of Cambridge and University of California, San Diego
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...
Lazy Susan-style table developed for total body irradiation

“This work aims to develop a comfortable TBI technique that achieves a uniform dose distribution to the total body while reducing the dose to organs at risk for complications.”

—Assistant Professor Xuejun Gu, Ph.D.

UT Southwestern radiation oncologists and physicists recently created a rotating, lazy Susan-type device that can turn patients a full 360 degrees while undergoing total body irradiation in either the supine or prone positions.

“Traditional extended source-to-surface total body irradiation (TBI) techniques can be problematic in terms of patient comfort and/or dose uniformity,” says Assistant Professor Xuejun Gu, Ph.D., one of the developers of the indexed rotatable immobilization system (IRIS). “Patients who stand during the procedure can become tired very easily and shift, which necessitates replanning,” says Dr. Gu. “When patients stand, it’s also not possible to give a dosimetrically accurate dose. It’s a very old-school approach to radiation therapy.”

The IRIS includes a base layer, a rotating disc, and a full body frame as the top layer. The universally adaptable base layer anchors to CT and LINAC couch tops of all major vendors using standard indexing bars common to radiotherapy immobilization devices. The top layer (full body frame) is fully indexed in the coronal plane to enable accurate image-guided patient setup as well as matching of multiple isocenters. The top layer also serves to immobilize the patient to reduce movement out of radiation ports. A rotating disc situated between the base and top layers allows the top layer to rotate around a pivot point.

The entire body CT scan is split into two sections due to the limited scan length of CT scanners. The patient is scanned headfirst from head to upper thigh, and then feetfirst, following a 180-degree rotation of the frame. These two CT scans are imported into Pinnacle and concatenated using Pinnacle’s concatenation tool. Treatment planning matches multiple isocenter volumetric modulated arc (VMAT) fields of the upper body and multiple isocenter parallel-opposed fields of the lower body.

Radiation Oncology is currently using the new device to treat patients requiring TBI. @

Clinical Trials

BRAIN

072012-034 A prospective, multicenter trial of Inovio<sup>TM</sup> VISA together with temozolomide compared to temozolomide alone in patients with newly diagnosed GBM

042011-075 Intratumoral radiofrequency implants for the treatment of pan-neoplastic plurihedral microcancer

042011-080 A phase II trial of hypercapnal-anoxia vehicle-brain irradiation with concurrent integrated boost for treatment of brain metastases

EMD3 A phase II study of radiation therapy with or without temozolomide for symptomatic or progressive low-grade gliomas

GASTROINTESTINAL

032012-045 Perspectives of targeting radiobiological pathways in combination with taxane and radiation therapy for the treatment of stage II and III rectal adenocarcinoma

GYNECOLOGIC

New—082013-06A A phase II study for image-guided hypofractionated radiation boost therapy for definitive treatment of locally advanced cervical cancer

072012-128 A randomized phase II study of standard vs. MTX pelvic radiation for postoperative treatment of extramammary and cervical cancer (TME-C)

HEAD AND NECK

062012-052 A phase I/II study of CyberKnife accelerated helical tomotherapy for early-stage glioblastoma multiforme

072012-128 A randomized phase II/I trial of surgery and postoperative radiation delivered with concurrent cisplatin versus docetaxel and cetuximab for high-risk aurallymphatic cancer of the head and neck

062013-001 A phase II randomized, double blinded, placebo-controlled study of liquidform (Tylosin<sup>®</sup>) for non-HPV locally advanced head and neck cancer with concurrent chemoradiation

052013-002 A phase II trial of postoperative radiation therapy (SRT)/<sup>®</sup> carboplatin for locally advanced head and neck cancer

062013-100 A randomized phase II trial of stage IV metastatic melanoma versus radiation alone in resected high-risk malignant salivary gland tumors

LUNG

082013-09A A randomized phase II study of individuated combined modality therapy for stage I non-small cell lung cancer (NSCLC)

062012-53 A randomized phase I/II trial of rabiximab, or paclitaxel with concurrent radiation therapy followed by consolidation in patients with favorable prognosis inoperable stage IIA NSCLC

032013-05A A phase II randomized study of standard versus accelerated hypofractionated image-guided radiation therapy (SBRT) in patients with stage II-B non-small cell lung cancer and poor performance status

SPINE

072013-134 A phase II trial of stereotactic body radiotherapy and vertebroplasty for localized spine metastasis

092013-001 A phase I/I study of image-guided radiosurgery/SBRT for localized spine metastasis

For more information, please contact Clinical Research Manager Jean Wu at 214-633-1753 or jean.wu@utsouthwestern.edu.
Department of Radiation Oncology
5801 Forest Park Rd.
Dallas, TX 75390-9183

Physicians who would like to make a referral may call the department’s main clinic number at 214-645-8525 or UT Southwestern’s physician referral line at 214-645-8300 (toll-free 866-645-5455) for adult patients, or 877-445-1234 for pediatric patients.

W.A. Monty and Tex Moncrief Radiation Oncology Building
5801 Forest Park Rd.
Dallas, TX 75390-9183

Annette Simmons Stereotactic Treatment Center at UT Southwestern
Zale Lipshy University Hospital
5151 Harry Hines Blvd.
Dallas, TX 75390-9183

Harold C. Simmons Comprehensive Cancer Center–Radiation Oncology
2001 Inwood Rd.
Dallas, TX 75390-9183

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