WORLD'S FIRST CLINICAL USE OF GEM RT OPEN‡ HNU SUITE IN RT PLANNING

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With an estimated global incidence of 533,000 cases each year, head and neck cancer is the fifth most common cancer worldwide.[1] In cancer treatment, radiation therapy (RT) often plays a significant role; however, it requires careful planning to avoid irradiating critical structures or non-cancerous tissues. When non-cancerous tissues are irradiated, patients can experience adverse reactions. In head and neck cancer treatment, these can include taste impairment, decreased salivary function, and difficulty swallowing.

‡ The GEM RT Open array is currently only available with the GEM 1.5T wide bore MR.

Figure 1. MR simulator configured for radiotherapy planning with flat tabletop, MR-compatible immobilization devices, and laser system for guidance.

Figure 2. Typical patient setup for the GEM RT Head & Neck Suite. The open architecture comfortably facilitates radiotherapy mask and immobilization system.

The use of MR to delineate and define both healthy tissue and the target area is increasing due to the superior soft tissue contrast provided over CT, and therefore improved delineation accuracy. By avoiding irradiation of healthy tissues and organs, the incidence of complications can be reduced.

Since 2010, the National Center for Cancer Care & Research (NCCCR) in Doha, Qatar has been pioneering the implementation of MR imaging in its clinical radiation therapy program. According to Gregory Perkins, Chief Radiation Therapist, NCCCR and program lead for the MR-SIM project, MR imaging for oncology treatment planning is currently used on about 50% of all cancer patients. This includes 100% of brain/neuro, head and neck, prostate and gynecological tumors, as well as extremity sarcomas and retroperitoneal tumors. NCCCR has also adopted GEC-ESTRO guidelines for gynecologic brachytherapy, which incorporates MR imaging into the treatment planning and dosimetry process.

In general, Mr. Perkins explains, "Imaging for radiotherapy treatment planning requires both high resolution and sufficient image contrast in order to aid the clinician in defining specific targets. The exquisite soft tissue resolution is a major advantage of using MR over other imaging modalities for localization of therapy."

Open, comfortable coil design

NCCCR Qatar was the first worldwide clinical user of GE Healthcare's new Geometry Embracing Method (GEM) RT Open Head and Neck Suite on the Optima™ MR450w 1.5T wide bore system, enabling high-resolution, large field-of-view (FOV) scanning while the patient is in the treatment position.

Patients for head and neck radiotherapy are usually immobilized with a treatment mask system to help improve precision. The coil suite facilitates the acquisition of high-quality images of the head, neck, and brachial plexus anatomies without compromising the immobilization of the patient, which historically was a limitation for adapting MR to this anatomical site.

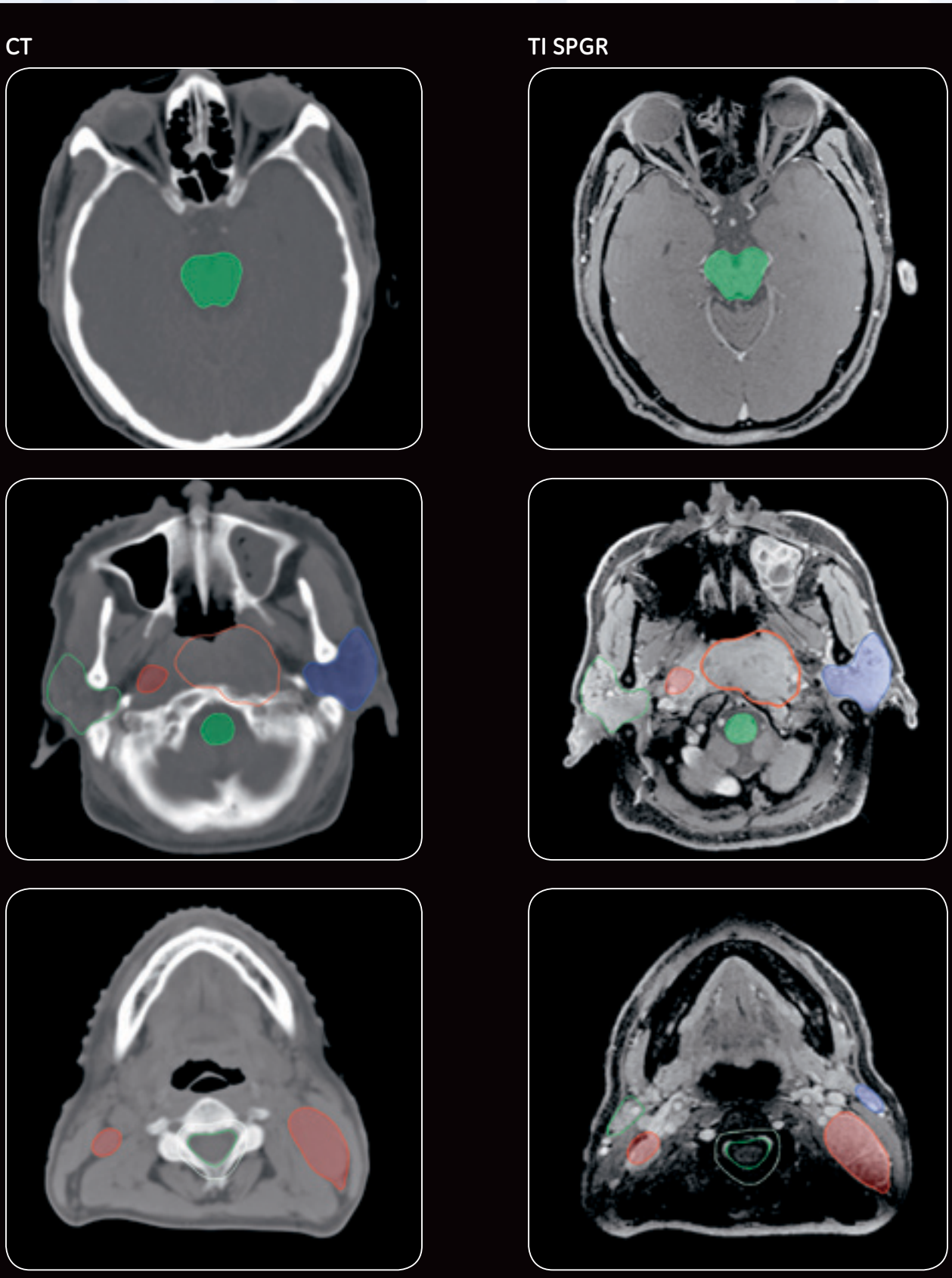

Figure 3. CT and co-registered MR-SIM images over various anatomic levels of the head and neck for a patient with advanced nasopharyngeal cancer. The superior soft tissue contrast resolution of the MR dataset facilitates improved confidence in delineating tumors and organs at risk.

T2 PROPELLER

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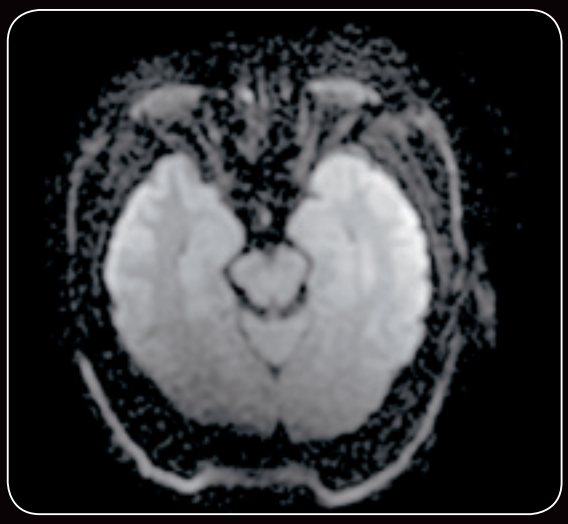

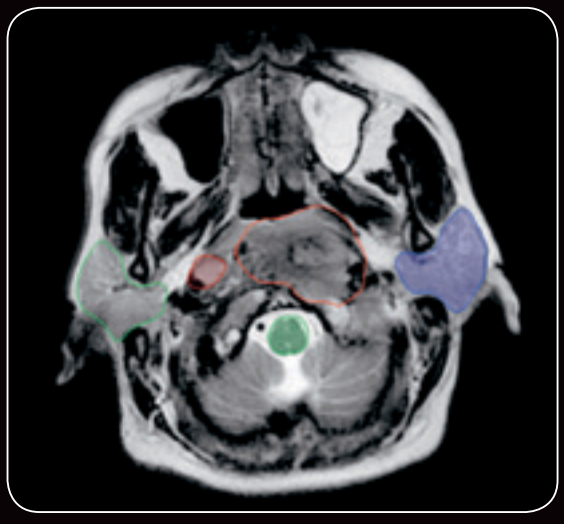

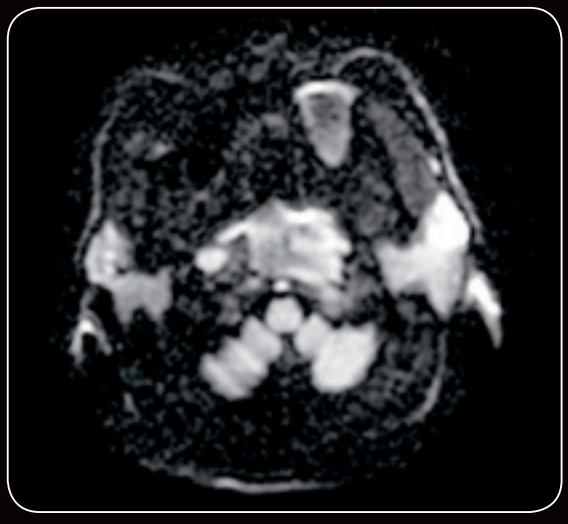

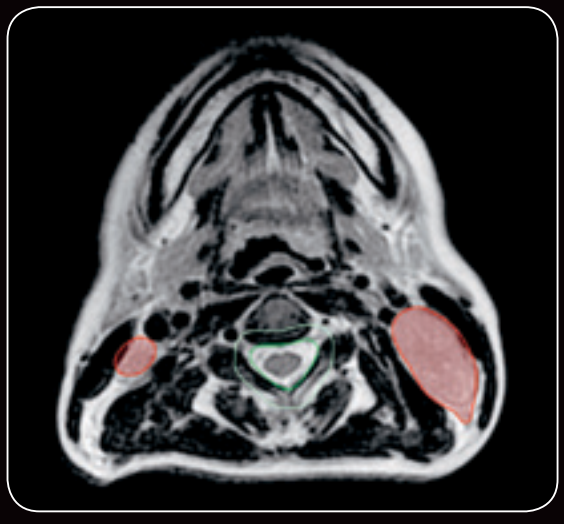

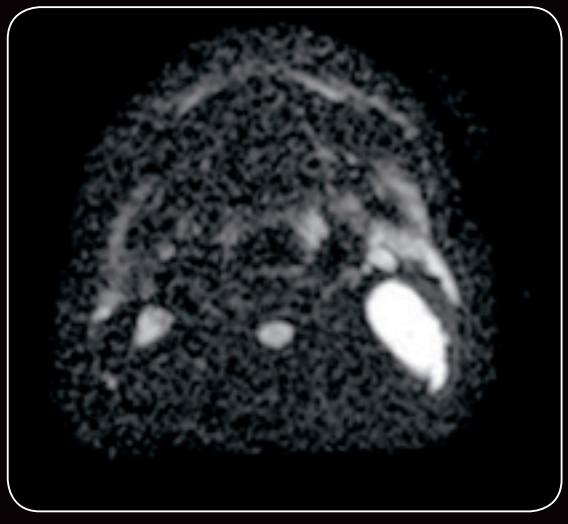

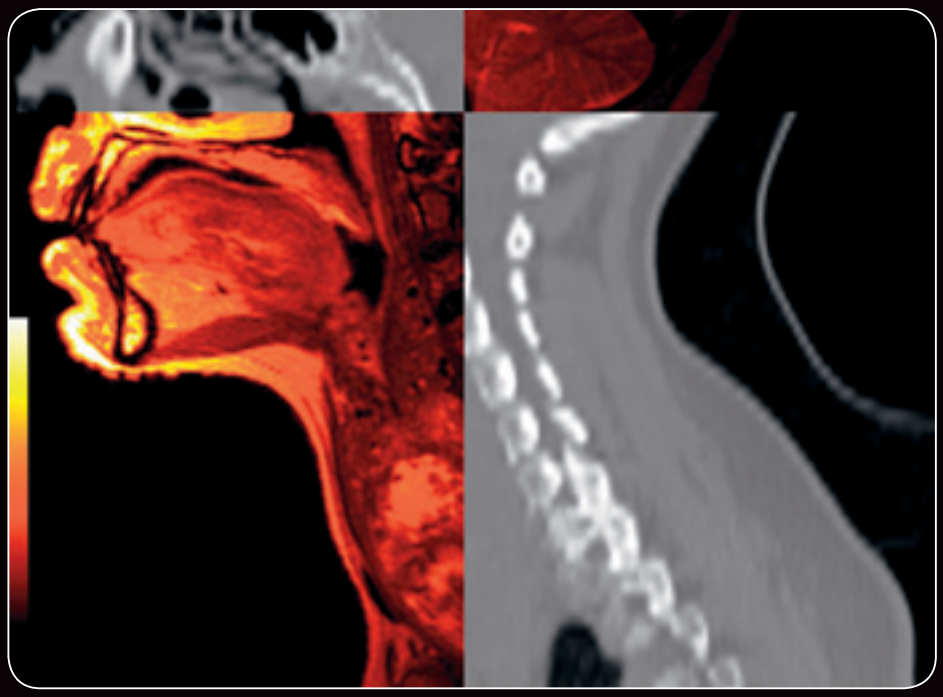

Figure 4. Excellent image co-registration achieved between the treatment planning CT and MR due to common immobilization and patient positioning, accommodated by the GEM RT Open Head & Neck Suite.

"GE's GEM RT Suite currently offers the only open architecture head and neck RT imaging coil, so we can image all the relevant anatomy with the patient immobilized in the treatment position," says Mr. Perkins.

Excellent image quality helps clinicians accurately plan for treatment. Mr. Perkins elaborates, "We strive to provide a patient-focused radiation oncology service and have been able to implement a technology which enhances patient care without compromising the patient experience. The GEM RT Suite provides exquisite planning images facilitated by an open architecture coil design that, when combined with the 70 cm wide bore design, provides our patients with a more comfortable scanning experience."

He continues, "A further advantage of the GEM RT Suite solution is its ability to achieve the large scan coverage typically required for radiation oncology planning. In the head and neck region, excellent coverage is achieved from the base of the brain to below the clavicles, due to the efficient design of the coil arrays. Furthermore, according to Mr. Perkins, the large FOV in the treatment position is a real advantage. "The GEM RT Suite has expanded the range of treatment sites where MR imaging is applied." Mr. Perkins adds that the coil mounts are well designed to allow for positioning of the coils close to the anatomy without contact, which enables good SNR without disrupting the body contour that can lead to distortions.

Workflow flows

The typical imaging sequence for RT planning at NCCCR consists of a T1, T2, fat suppressed T1 with contrast, and diffusion-weighted imaging. The coil solution is compatible with parallel imaging and other new imaging techniques, many of which allow fast imaging. Mr. Perkins explains, "Shorter examination times are very critical in radiation oncology as the treatment table is rigid and patients are often immobilized. Previously, examination times could be up to one hour. Parallel imaging has resulted in considerable time savings and currently, typical examination time has been reduced to approximately 20 minutes."

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>
> *Gregory Perkins*

In addition to parallel imaging, NCCCR routinely uses GE's 3D isotropic FSE imaging sequence—Cube—for T1 and T2 acquisitions. With Cube we can collect a T1 or T2 volumetric imaging slab in just five minutes. Cube provides the same isotropic resolution in any plane—axial, sagittal, or coronal—so that the spatial relationships of the tumor and the surrounding anatomy can be visualized in any plane. This could not be obtained with conventional 2D MR imaging techniques.

PROPELLER is another key enhancement to imaging sequences that benefit radiotherapy patients, particularly in regions where anatomy can be prone to motion. Mr. Perkins notes, "In the head and neck region, head movement and swallowing may lead to motion artifacts and image blurring. T2 PROPELLER has improved the image quality in the head and neck region, and also other sites such as gynecologic and urology applications, where MR imaging also plays a key role in radiotherapy planning."

Positioning and accurate image registration

RT treatment planning and dose calculation is based upon CT imaging, due to inherent electron density information, and hence image co-registration to the MR is necessary. In order to achieve an accurate registration, patients are imaged in the treatment position for both modalities. During long examinations, the patient is more likely to move and deviate from the planning position, which can impact accuracy of registration. Mr. Perkins summarizes, "We are able to achieve excellent image registration between the CT and MR data sets in this patient population, in part due to the improved patient comfort associated with the wide bore design of the Optima MR450w, the open architecture of the GEM RT Suite of coils, and the quicker examination times."

Looking forward

As a pioneer in using the GE MR solution for RT planning, Mr. Perkins has two suggestions for his peers: First, optimize the protocols for RT planning right from the start. Second, share information with peers. This is vital for effective utilization and continued exploration of this technology, he says. "The learning curve is steep as the application to our discipline is new, but once you get there, incorporating MR protocols to the radiation therapy pathway becomes more routine."

He concludes by saying, "In the next five years I think every oncology department will invest in an MR system. More and more image-guided therapies are looking to exploit MR-based solutions. This is why we are investing in and adopting this technology. We believe that at the NCCCR, MR has made a difference to clinical practice and enhances our overall confidence in the treatment planning process."

Reference

1. Goon PKC, Stanley M, Ebmeyer J, et al. HPV & Head and Neck Cancer: a Descriptive Update. Head Neck Oncology 2009, 1(1):36.

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The Department of Radiation Oncology at the ***National Center for Cancer Care & Research****, Doha, Qatar, is a JCI and IAEA accredited center of cancer excellence serving the State of Qatar. State-of-the-art radiation oncology services include VMAT treatment delivery, 6D-guided frameless stereotactic radiosurgery, MR-guided brachytherapy, and PET-CT with gating capabilities.*