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chief physicist

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The radiotherapy unit at Herlev University Hospital investigates use of MRI for radiotherapy treatment planning

In radiotherapy planning, it is important to determine the tumor position and shape with high precision. Traditionally, CT images are used for planning, but there is a worldwide trend of growing MRI use in Radiation Oncology. The Herlev team uses MRI in a large fraction of its patients as the excellent MR soft tissue contrast helps to clearly delineate lesions.

The radiotherapy unit in the oncology department at Herlev University Hospital, close to Copenhagen in Denmark, takes in about 3,000 patients every year, which adds up to more than 55,000 treatments on 10 linear accelerators. The Philips Panorama HFO adds MRI to help clinicians to prepare and plan for radiotherapy treatment in cancer patients.

"We see many advantages of using MRI in the radiotherapy process," says Poul F. Geertsen, MD, PhD, head of radiotherapy at the hospital. The soft tissue visualization is obviously much better on MR than CT. We get true sagittal and coronal images, and much better definition of the outline of the tumor (gross tumor volume, GTV). "An optimized definition of the tumor volume provides the potential for margin reduction, with reduced toxicity."

Special attention for geometric precision

"For RT planning it is crucial to correctly determine the tumor location and geometry," says chief physicist Brian Holch Kristensen. "Therefore, we use a dedicated toolset, containing, for example, a flat tabletop, an external laser bridge and gradient distortion correction algorithms software.

The open Panorama MR system offers the space needed. "The patient setup on the tabletop is very strict for radiotherapy work. Immobilization devices such as casts, masks and supports have to fit within the scanner, and must be fixed via the tabletop's indexed edges. For instance, in head and neck tumors we use a thermoplastic mask made of MR compatible materials that can be easily used in combination with the Panorama coils, with good image quality. Also, a normal MRI scanner has a curved tabletop and cushioning, but we use a flat, hard tabletop that supports high reproducibility of the patient's position from CT and MR imaging to treatment planning and delivery and between different treatments."

"We do more QA than in a normal scanner," he adds. "As it's very important that the tumors are properly visualized, phantom testing is performed on the system once a week, to test the image distortion, and external laser and geometry precision in general. We have special QA phantoms to test all these things."

MR incorporated in treatment planning workflow

"We fuse the MR images onto a CT image before treatment planning," says Dr. Kristensen. "To best register the MR images to CT, our ExamCards are optimized for radiotherapy;

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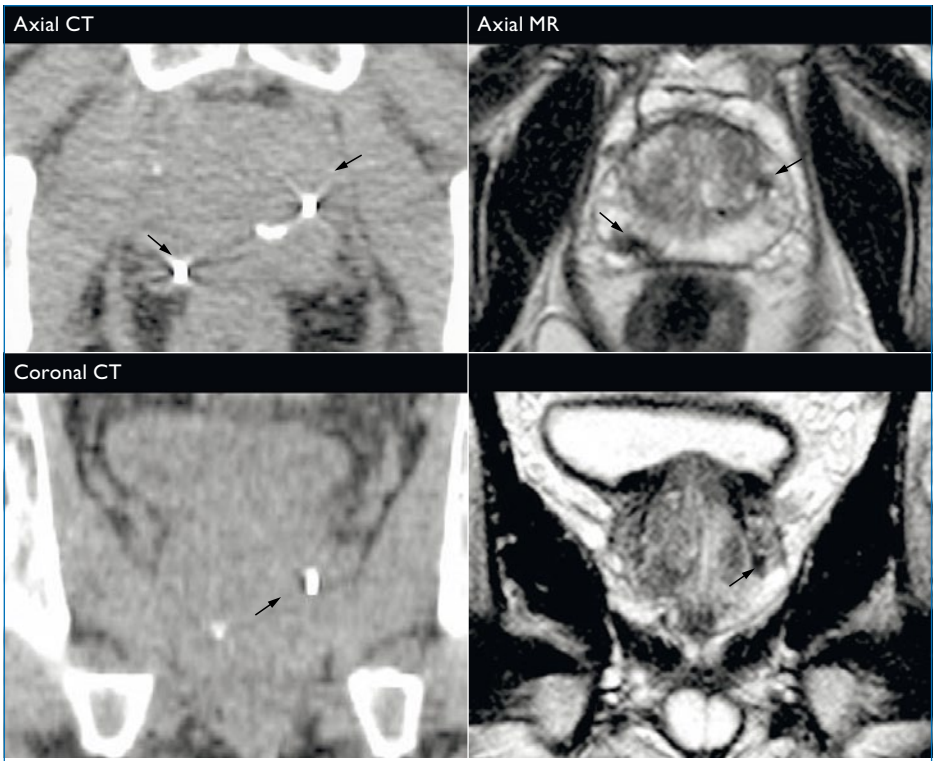
similar image acquisition parameters are needed, so we do axial MRI scans with the same slice thickness, and of course the same patient fixation and fiducial markers. The fiducial markers used in prostate are also quite visible using MRI. We export the images to our radiotherapy treatment planning system (RTP) and handle the images further in that system."

"We need the high soft tissue contrast of an MRI scan to visualize the tumor," explains Dr. Kristensen. "MR is usually combined with CT, because we still use CT to calculate the dose distribution. It's the combination of the two modalities that currently produces the best results. Nevertheless, we are working on MRI only in brain and for some indications in the pelvic area as well."



Prostate

It is important to delineate the prostate accurately for radiotherapy planning to be able to spare normal tissue when irradiating. The prostate is easily identified on axial MRI compared to CT. Furthermore, coronal or sagittal MR scans help to define the top and bottom (base/apex) well, whereas this is very difficult on CT. It is very important for the patient to be able to spare the bladder, rectum and penile bulb (erection).

Fiducial markers (arrows) are often used within the prostate to identify the prostate at the treatment unit (linac). These markers are also used to transfer the MRI information (delineation) onto CT images. Full body image fusion is not accurate because the prostate moves between scans. However, Nitinol markers are visible on both CT and standard T2 MRI.

CONTINUE

Herlev University Hospital

"Advantages of using MRI in RT planning are the superb soft tissue visualization and true sagittal and coronal images, providing much better definition of the outline of the tumor."

Modalities and team members work together

"Several types of treatment are supported by MR imaging, including external beam radiation and brachytherapy," says Dr. Geertsen. "Normally, a patient is scanned one week before treatment to help better define the tumor positioning and size for the planning. Some patients are also scanned up to two times per week after the start of treatment to follow tumor response, for instance by looking at tumor response with diffusion weighted imaging."

"The MR scan is done by the same person who scans on CT. The scans are viewed by a radiologist and a radiation oncologist together; every day from 11:00 to 1:00, the radiologist comes to our department and sits with the oncologist to view MRI images, CT images, or both. Then we export it out to a third-party treatment planning system."

"That collaboration is very important," he adds. "An MRI scanner can be very challenging to run in the best manner, so it's best to work together. If we have any downtime, we can even share a machine."

Reference

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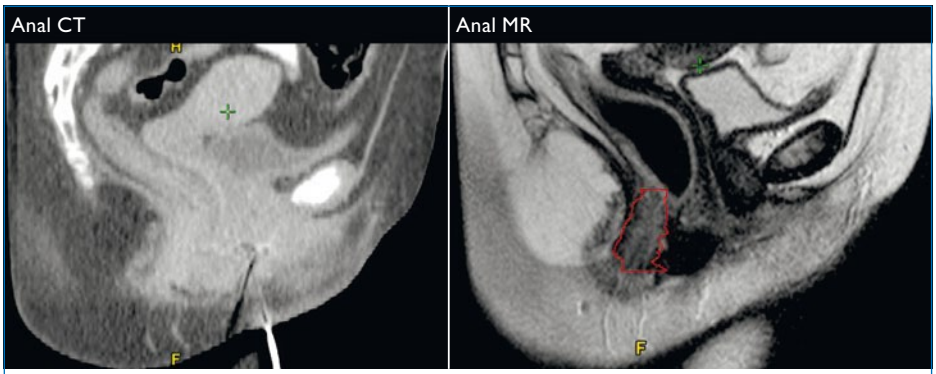
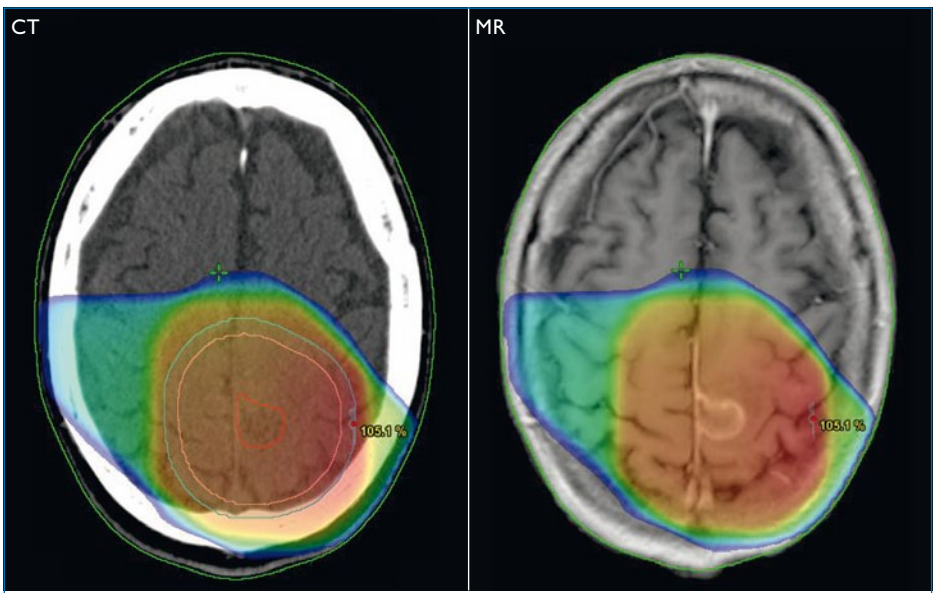


Anal cancer
A soft tissue tumor can be very difficult to see on CT. With MRI the tumor is much better visualized. In addition, the possibility to acquire true sagittal MR images helps to visualize the top and bottom of the tumor.



Brain
On CT the tumor cannot be seen, but on contrast-enhanced T1 MRI the tumor is clearly seen. The radiation dose calculated on both modalities shows that the dose calculation can be done directly on the MRI omitting the CT.

Panorama HFO Oncology Configuration

The Philips Panorama HFO Oncology Configuration helps radiation oncologists to fully benefit from MRI's excellent soft-tissue contrast by providing a means of repeatable patient positioning from scanning to planning to treatment. The spacious 160 cm-wide patient aperture of the system facilitates patient positioning, while dedicated software and hardware tools support patient immobilization and alignment.

Panorama HFO Oncology Configuration with external laser positioning system for patient alignment, and flat table top for imaging the patient in treatment position. The system offers dedicated ExamCards for Radiation Therapy and supports CT and MR fusion.

Ingenia configuration for RT planning in development

Philips Ingenia, the first-ever digital broadband MR system, features dStream technology. In the Ingenia configuration for RT planning, Ingenia's fast scanning and high SNR are combined with a flat tabletop allowing patients to be scanned in the treatment position. The flat tabletop is compatible with the FlexTrak trolley, for easy patient transport from MRI to treatment suite. Ingenia's superb field homogeneity together with the one-click Travel-to-scan capability and the external laser positioning system benefit precise RT treatment planning.

Ingenia is designed for a smooth and efficient workflow. Coils that are easy to set up help reduce patient setup time and increase speed, also when scanning for radiotherapy planning.

With all the advantages of the Oncology Configuration, plus easy coil handling and simplified workflow in a powerful 1.5T or 3.0T system, Ingenia is outlined to be a powerful system in MR-RT treatment planning.