Multi-parametric prostate and whole-body oncology MRI exams

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In multi-parametric MRI, the multiple contrast mechanisms provide more information about lesions that can help in diagnosis. Multi-parametric MRI can include T1-weighted, T2-weighted, diffusion-weighted imaging (DWI), DCE and spectroscopy. Dr. Shonit Punwani and his team at the University College Hospital London developed multi-parametric MRI exams for prostate imaging and whole-body imaging.

“When MRI is used to assist in the initial diagnosis, a multi-parametric approach offers more information.”

UCLH (University College London Hospital) is a leading hospital in the UK. It has an Achieva 3.0T and an Ingenia 3.0T installed at the MacMillan Cancer Centre. The Achieva system is used predominantly for prostate MRI but also for general work. The Ingenia system is used for dedicated scanning of oncology patients. In addition to the clinical services provided, the radiology department is at the forefront of medical research.

MRI has a range of applications in prostate imaging

“When prostate MRI is used for staging after cancer has been diagnosed, the goal of imaging is to visualize the lesions and determine if and where these are extending outside the prostate,” says Dr. Punwani. “That requires high quality anatomical imaging. However, when MRI is used to assist in the initial diagnosis, a multi-parametric approach offers more information. I use the additional information particularly for small tumors. For instance, when I see a lesion with low signal on T2-weighted images, and the additional DWI and the ADC map confirm the lesion has a reduced ADC, then I know that the lesion is likely to be cellular. Increased cellularity restricts the movements of water molecules, which leads to high signal on DWI and restricted ADC.”

“User experiences

Dr. Shonit Punwani is a Senior Lecturer in Oncological Imaging at University College London and Honorary Consultant Radiologist specializing in oncological radiology at University College London Hospital. He co-leads the 3T MR Research Facility at UCLH, developing novel MRI techniques for first-in-man oncological imaging studies. He has a specialist clinical and research interest in the application and development of local and whole-body quantitative and functional MRI methods for imaging prostate.
“Not using an endorectal coil is more comfortable for the patient and currently the surface coil approach provides enough SNR for prostate imaging. When performing prostate MRI without endorectal coils, air in the rectum may cause susceptibility effects, particularly at 3.0T. So, in order to reduce the susceptibility effect, we use a small field-of-view DWI for generating the ADC map. We also include a separate high b-value DWI and have found both particularly useful. When I see focal areas of high signal on b2000 images and the rest of the gland is dark, I have a very high suspicion of cancer being present.”

**Multi-parametric prostate**

The axial ADC map demonstrates reduced diffusion within the anterior left transition zone of the prostate. This is consistent with increased cellularity within a tumor. Note that this region would not be undersampled by a standard TRUS biopsy procedure, and without MRI assisting in targeting a diagnosis of localized tumor could not be confirmed. The axial T2-weighted images demonstrate a subtle more homogenous area of reduced T2 signal within the anterior left transition zone similar in appearance to adenoma. The axial b2000 diffusion weighted image demonstrates significant residual signal within the left anterior transition zone at the tumor site. Signal elsewhere is almost completely absent. This was scanned on Achieva 3.0T TX.

“Why change the approach?”

“There is a clear need to change the way that we localize disease within the prostate. We would never perform a breast biopsy without first trying to localize the lesion using imaging. That is why we are now developing the necessary tools to localize disease within the prostate with multi-parametric MRI. We have been performing multi-parametric MRI of the prostate without an endorectal coil at 1.5T since 2006. The arrival of our Achieva 3.0T TX system and use of the 32-channel SENSE Cardiac coil significantly improved the signal to noise of our T2 and diffusion weighted images.”

Dr. Punwani and his team are also looking at MRI to help assess the effect of treatment. “Being able to localize lesions also opens the possibility to provide focal therapies, which treat only a part of the prostate rather than removing the entire organ. In such cases we can use MRI to monitor the effect of treatment. For post-treatment surveillance, if PSA is increasing, we can use multi-parametric MRI to localize recurrent/residual disease.”

**Multi-parametric whole-body MRI provides more information**

“The multi-parametric approach for whole body oncology imaging is a more recent development, which has been facilitated by the installation of the Ingenia 3.0T scanner. The 32-channel DS Torso coil solution makes whole body imaging using multiple contrasts within a reasonable overall imaging time a reality. We are very pleased with the results so far.”

“Being able to localize lesions opens the possibility to provide focal therapies.”

“One of the key benefits of multi-parametric MRI for whole-body exams is that, unlike PET, there is no radiation,” says Dr. Punwani. “This is especially important for pediatric patients who need many follow-up scans.”

“Also, FDG-PET does not detect all bone lesions. DWI methods have been shown to be useful at visualizing bone disease and could complement PET or other nuclear medicine techniques.”

“We perform all our multi-parametric whole body MR scans on the Philips Ingenia 3.0T,” says Dr. Punwani. “The new core technologies on the Ingenia allow us to use a multi-parametric whole-body approach in a reasonable amount of time. For anatomical imaging we do a free breathing TSE sequence.”
“Ingenia allows us to use a multi-parametric whole-body approach in a reasonable amount of time.”

**Multi-parametric whole body using Ingenia 3.0T**
Bone scan and mp-MRI concordant lesions in a patient with known prostate cancer. Two lesions are demonstrated on the bone-scan at T12 and T7 vertebral body levels. The coronal mDIXON in-phase image demonstrates both lesions as foci of low T1 signal. Coronal reformat of an axial diffusion b1000 scan (inverted contrast) demonstrates restricted diffusion within the T12 lesion. The axial T2-weighted image at the T12 level confirms low T2 signal.

**UCLH** (University College London Hospitals NHS Foundation Trust), situated in the West End of London, is one of the largest NHS trusts in the United Kingdom and provides first-class acute and specialist services. The state-of-the-art University College Hospital that opened in 2005, is the focal point of UCLH alongside five cutting-edge specialist hospitals. UCLH is committed to research and development and forms part of UCL Partners, which in March 2009 was officially designated as one of the UK’s first academic health science centers by the Department of Health. UCLH works closely with UCL, translating research into treatments for patients. For more information, see www.uclh.nhs.uk, Facebook (UCLHNHS), Twitter (@UCLH) or Youtube (UCLHvideo).
“These T2-weighted images are excellent. We also perform diffusion imaging of the whole body. We’re using SPAIR spectral fat suppression, not STIR as in DWIBS, to acquire four b-values. These help us to differentiate the diffusion components from other effects. The ADC maps are quite good. In the neck though, the susceptibility gradient may cause distortion in the ADC map. One of the things we can do is add a STIR EPI on the neck after scanning the entire body, which tends to have fewer artifacts.”

“Next, we use body mDIXON imaging: acquiring in-phase, out-phase images and deriving fat and water images. This provides us with excellent anatomical resolution.”

“The liver is a special case in most whole-body images, because we want to be able to pick up liver lesions, which we don’t necessarily see without contrast. So, we do dynamic imaging, which is acquired every 20 seconds, and has multiple breath holds through the liver.”

“I’m getting more and more clinical requests in for multi-parametric MR to visualize disease and response to treatment in different clinical areas,” says Dr. Punwani.

**Summary: why a multi-parametric approach**

“Combining multiple contrast mechanisms allows us to look at different aspects of tumor biology – for example, cellularity, vascularity, fat/water percentages – and together these provide more information than any one particular technique. And I think that’s very powerful, particularly where patients have heterogeneous tumors where not all lesions are seen by any one technique. Also by evaluating multiple aspects of tumors we may be able to not only see the disease but hopefully develop methods to better predict the responses to treatment.”

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**Multi-parametric whole body using Ingenia 3.0T**

Bone scan and mp-MRI discordant lesion in a patient with known prostate cancer, suggesting mp-MRI may be more sensitive than bone scan. No iliac bone lesion is seen on the bone scan. The coronal mDIXON in-phase image demonstrates subtle hypointense T1 signal within the left ilium (red arrow). The axial diffusion b1000 image (inverted contrast) demonstrates restricted diffusion at the corresponding site within the left ilium (red arrow). The axial T2-weighted image at the site confirms a typical appearance of a low T2 signal metastatic deposit (red arrow). Combining multiple contrast mechanisms provides more information than any one particular technique, which is powerful when not all lesions are seen by any one technique.