Specialty area: Rising PSA: Is There A Cancer?

Jurgen J. Fütterer   **j.futterer@rad.umcn.nl**

Highlights:
- Males with rising or elevated PSA and negative prostate biopsy is a challenge for both the urologist and patient.
- MP-MRI may discriminate between benign and malignant prostate disease.
- Image-guided biopsy is of benefit for the patient.

Prostate cancer is a major health issue in aging men. No treatment is required in less aggressive prostate cancer but there is consensus that radical treatment is needed in aggressive prostate cancer. Radical treatment has to start while the tumor is still confined to the gland and has not spread beyond. Potential side effects of radical treatment, such as impotence and incontinence, have a substantial impact on quality of life. This is of special importance because more than 25% of patients eligible for radical treatment are in the age range of 40 to 65 years.

Conventional anatomical T2-weighted MR imaging is the mainstay in prostate cancer imaging. On T2-weighted MR images, normal prostate tissue displays an intermediate to high signal intensity while the central gland has lower signal intensity than the peripheral zone. Currently several new MR imaging techniques are being explored. These include: [1]H-MR spectroscopic imaging (MRSI), dynamic contrast-enhanced MR imaging (DCE-MRI), and diffusion weighted imaging (DWI).

MRSI is a unique method that can provide information based on tumor metabolism. The chemical environment of protons within a certain molecule defines their so-called chemical shift: a unique resonance frequency when positioned in a magnetic field, which can be observed in an MR spectrum. Specific spectral profiles reflect the identity of (bio-) chemicals present at that location and the intensity of the spectral signals is related to the tissue levels of these compounds. Analytical and clinical studies have shown significant differences of the metabolic state of the different tissue types by MRSI.

Dynamic contrast-enhanced MR imaging – with a low molecular weight contrast media (<1 kDa) enables non-invasive imaging of tumor angiogenesis. DCE-MRI is the most common imaging method for evaluating human tumor vascular function in situ. Insights into these physiologic processes are obtained qualitatively by characterizing kinetic enhancement curves or quantitatively by applying complex compartmental modeling techniques. Data reflecting the tissue perfusion (blood flow, blood volume, and mean transit time), the microvessel permeability, and the extracellular leakage space can be obtained.

Diffusion weighted MR imaging – can quantify the water motion in an indirect manner. The DWI pulse sequence labels hydrogen nuclei in space, of which most will be part of water molecules at any moment, and determines the length of the path that water molecules travel over a short period of time. DWI is able to estimate the mean distance traveled by all hydrogen nuclei in every voxel

of imaged tissue. The greater this mean distance the more self-diffusion of water molecules has taken place in a certain time interva . From this estimate an apparent diffusion coefficient (ADC) as a reflection of the self-diffusion of water in tissue in a certain direction can be calculated.

Multiple studies have explored optimal parameter settings for the diagnostic MR-protocol, which allows accurate tumor localization. Although reported accuracies of the different separate and combined multiparametric MR imaging techniques vary for diverse clinical prostate cancer indications, multiparametric prostate MR imaging has shown promising results and may be of additional value in prostate cancer localization and local staging. To increase MR imaging accuracy for the different clinical prostate cancer indications, one or more functional MR imaging techniques should be combined with T2-weighted MR imaging in a multiparametric MR imaging exam of the prostate.

The optimal strength of multiparametric MR imaging is yielded by combining the information of the various techniques. Computer programs, which allow evaluation of two or more multiparametric images in one view, need to be developed for the integrated interpretation of the anatomic and functional techniques. Development of supportive techniques like computer aided diagnosis is needed to achieve fast and reproducible diagnostics on large quantities of complex data.