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The pros and cons of prostate MRI: detection, localization, and staging

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Prostate carcinoma is the fifth most common cancer in men in Taiwan. In the past decade, the death rate of prostate cancer has raised up to seven folds. Recently, because of screening with prostate-specific antigen (PSA) level, there has been a dramatic downward trend in the stage of prostate cancer determined at the time of diagnosis, which brought new challenges for imaging diagnosis of prostate cancer. First, currently for those with elevated PSA, diagnosis of prostate cancer is primarily made by transrectal ultrasound (TRUS) biopsy. It is an invasive procedure with considerably high false negative rate. For those with elevated PSA and negative TRUS biopsy results, reliable diagnostic method for tumor detection is required. Second, the presurgical detection of extracapsular extension is important for subsequent treatment selection and surgical planning. Third, disease targeting therapies - including intensity-modulated radiation therapy, interstitial brachytherapy, cryosurgery and high-intensity focus ultrasound - have been under developing aiming at treatment for localized prostate cancer. Effective treatment depends on reliable imaging for tumor localization and treatment guidance.

Magnetic resonance (MR) imaging is a direct and noninvasive way for pretreatment assessment for prostate cancer. T2-weighted MR images could provide detail anatomical information of the tumor by demonstrating the low signal intensity (SI) cancerous areas within the high SI background of healthy peripheral zone tissue. Giving its high resolution and tissue contrast, it could evaluate local tumor extent. By identifying the presence of extracapsular invasion (irregular contour bulging, asymmetric neurovascular bundle, obliterated rectoprostatic angle, overt extracapsular tumor, periprostatic infiltration and seminal vesicle invasion, T3 stage diseases could be identified and proper treatment strategies could be made accordingly. However, by anatomical images (T2-weighted images) alone, the diagnostic accuracy did not meet clinical requirement concerning tumor detection and localization. This has motivated the development of functional imaging.

In vivo ^{1}H MR spectroscopic (MRS) imaging, provides NMR signals (spectra) of some of the metabolites present in the prostate gland, which can detect cancer by the elevation of choline-containing compounds (Cho) and the reduction of citrate (Cit) in cancerous tissue compared with healthy prostate tissue. It aids in defining the presence, spatial extent, and aggressiveness (grade) of prostate cancer, provides an early means of determining therapeutic success and detecting recurrence after treatment. Diffusion-weighted imaging (DWI) is another functional technique, which provides information about water composition within a tumor and normal tissue and thus differentiates these two. It has been proved that DWI effectively improve the accuracy of both tumor localization and staging. The main limitation of DWI is its difficulty in detecting small tumor focuses and differentiating normal transitional zone and cancerous tissue. Dynamic contrast enhanced imaging (DCE-MRI) has been under investigation. Cancerous tissue is found to enhance more rapidly and to a greater degree as compared to the benign peripheral zone. However the main limitation of DCE-MRI is transitional zone tumor, where the benign hyperplasia tissue may be mistaken as cancerous tissue.

MR techniques for diagnosing prostate cancer will be discussed in this talk, focusing on its role in clinical application. Technical issues such as the application of endorectal coil and comparison between 1.5T - 3T will also be addressed.