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REVIEW ARTICLE

MAGNETIC RESONANCE IMAGING FOR PROSTATE CANCER

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ABSTRACT

Prostate cancer is the most frequently diagnosed cancer in males and the second leading cause of cancer related death in men. The successful management of prostate cancer requires early detection ,appropriate risk assessment and optimum treatment. The routine tools for early diagnosis and localization of cancer with the prostate include digital rectal examination and assessment of serum prostate specific antigen followed by trans rectal ultrasonographically guided biopsy. However because of the low sensitivity and specifity of these detection techniques a substantionalefeeort has been made to develop and evaluate new diagnostic techniques. Compared with the results of transrectal US, magnetic resonance imaging results have demonstrated a much higher sensitivity. With the recently published national institute of clinical excellence guidelines, it is more generally accepted that MRI is the imaging method of choice for staging prostate cancer in patients for whom radical treatment is being considered.MRI can locate the site of intraprostatic disease which may prove useful in planning disease, targeting therapies currently being developed. The advantage of this technique include the direct depiction of tumor vascularity and possibly obreation of an endorectal coil .This article reviews the current applications MRI in clical practices and discuss the promise of these modalities for improving prostate cancer management.

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INTRODUCTION

Prostate cancer is the most frequently diagnosed cancer in males, accounting for 25% of all cancers in males (192,280 of 766,130 newly diagnosed cancers in males in 2009), compared with 15% for lung cancer. It is the second leading cause of cancer-related death in men, making up 9% of cancer deaths in males (27,360 of 292,540 cancer-related deaths in males in 2009), a value exceeded only by the death rate from lung cancer in males (30%). Sixteen percent of males (one in six) will develop prostate cancer during their lifetime (Atlanta Ga, 2009). Most prostate cancers grow slowly (Johansson, 1997; Pound, 1999) and early detection can lead to a complete cure. However, in more than 85% of cases of prostate cancer, multiple cancer foci are found in the prostate (Pound, 1999). An increased incidence of this disease is expected in the coming years (Becker, 2002). Only a malignant illness limited to the organ allows for a curative therapeutic approach. This requires early detection of the illness and, therefore, active participation in numerous screening examinations (Polascik, 1999; Mikolajczyk, 2002; Slawin, 2004; Thompson, 2004; Okotie, 2007).

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The prevalence of prostate cancer increases with age; 34% of men in the 5th decade of life and up to 70% aged 80 years or older have his tologic evidence of prostate cancer. The anticipated demographic change in an aging population is expected to increase the incidence of prostate cancer. Over the past 25 years, the 5-year survival rate for all stages of prostate cancer combined has increased from 69% to almost 99%. The corresponding 10-year survival rate is 93%, and the 15-year survival rate is 79%. The notable improvements in survival, particularly at 5 years, are commonly attributed to earlier diagnosis and improvements in treatment (Schnall, 1990; Moyher, ?). PCa is currently characterized by its TNM stage, Gleason score, and prostate-specific antigen (PSA) serum level. PSA testing is the mainstay of detection and has reduced the rate of death from PCa (Schnall, 1990).

Prostate cancer screening: There are various treatment options for prostate cancer like prostatectomy (for organ-confined T1 and T2 disease) and hormone ablation and radiation therapy (for advanced extraprostatic T3 and T4 disease).Another therapies includecryoablation, radiofrequency ablation, brachytherapy, photodynamic therapy, and high-intensity focused ultrasonography (US); however, these therapies require exact localization of the cancer (Schnall, 1990; Moyher, ?;).

Currently, prostate cancer screening is based on assessment of the level of PSA elevation and results of digital rectal examination (DRE). Both markers have suboptimal accuracy for the diagnosis of prostate cancer (Scher *et al*., 2003). Although several methods have been developed to predict patients' outcome it is still difficult to project which patients will experience progression of the disease. The most important predictors of prognosis in prostate cancer are the Gleason score and the clinical stage at the time of diagnosis (Schnall, 1990).

MRI of the prostate cancer: Magnetic resonance imaging (MRI) is emerging as the most sensitive tools for the non-invasive, anatomic and metabolic evaluation of prostate cancer. Although reports on the value of MRI in prostate cancer management have been contradictory, there is no doubt that MRI has an essential role to play in making safer, more individualized therapies possible. By revealing the anatomical location of prostate tumours, MRI can aid in staging and also provide a road-map for surgery or for radiation treatment. The signal intensity and detection of prostate cancer on MRI depend on the type of imaging sequence used. On T1 weighted images, the prostate demonstrates homogeneous medium signal intensity. On T2 weighted MR images, the zonal anatomy of the prostate can be seen, and cancermost commonly demonstrates decreased signal intensity within the high-signal-intensity normal peripheral zone (Hricak, 2005). However, low signal intensity in the peripheralzone can also be seen in several benign conditions such ashaemorrhage, prostatitis, hyperplastic nodules, or sequelaeresulting from radiation or hormonal treatment.

MRI technique: Although MRI has advantages over other cross-sectional imaging modalities such as CT, which requires ionizing radiation and nephrotoxic contrast media, MRI is notsuitable for everyone. Contraindications include cardiac pacemakers, intracranial aneurysm clips and intraorbitalmetal fragments (Kurhanewicz, ?).The development of magnetic resonance imaging (MRI) has been driven by the limitations of these modalities with the aim of improving staging accuracy prior to treatment, particularly in demonstrating the presence or absence of extra capsular spread. The mainstay of treatment for organ-confined prostate cancer is either radical prostatectomy or curative radiotherapy, although there is now debate as to whetherthe presence of extracapsular disease that patients with T3a or T3b disease can be considered for either radical prostatectomy or curative radiotherapy as long as their life expectancy is over 5 y (Swanson, 2001). The signal intensity and detection of prostate cancer on MRI depend on the type of imaging sequence used (HuchBoni, 1995). Although the ''optimal'' choice of equipment (specifically, magnet strength) and imaging sequences depends on the instruments available. Radiofrequency coils within the released MRI signals necessary to construct representative images. The built-in body coil was the only coilavailable when MRI was first developed, but now surface coils, such as the pelvic phased array (PPA), are more commonly used and placed on the patient over the region of interest. The end rectal coil (ERC) is as pecialised surface coil that is introduced rectally and held in place by a balloon. With a small field-of-view and position immediately adjacent to posterior prostate, higher spatial resolution is achieved, although patient discomfort can lead to possible motion artifact. When combined with the PPA to provide an integrated system(ER-PPA coil), the whole pelvis can be assessed. As mooth muscle relaxant, such as glucagon or hyoscine butylbromide, can be administered to reduce bowelmotion artifact. Sequences acquired should include axial T1 weighted fast spin echo (FSE) images from the aortic bifurcation to the symphysis pubis to give an overview of the whole pelvis. High-resolution fine-section axial, sagittal and coronal T2 weighted FSE images show the seminal vesicles and zonal anatomy of the prostate down to apex. Large field of view T1 weighted coronal or sagittal images are helpful for assessing bone marrow for metastatic involvement. Fat suppressed sequences have no staging benefit over conventional T1 and T2 weighted FSE imaging. A gadolinium-based contrast medium can be administered intravenously. Gadolinium will usually increase signal intensity on T1 weighted images but the effect does depend on tissue perfusion. Dynamicenhancement can improve tumour detection in prostate (Kurhanewicz, ?; Swanson, 2001).

Detectability by MRI: The detectability by each modality is shown in Table 1.The sensitivity of each MRI sequence was significantly higher than TRUS. The sensitivity of biopsy was significantly higher than those of TRUS and MRI. The sensitivities of DWI and ADC map were significantly higher than that of T2WI . The cT1c cases where no local lesions were detected in DRE, TRUS, and MRI, and that were finally diagnosed as cancer in a subsequent biopsy accounted for only 13.1%. In 86.9% of the patients, local lesions were identified with T2WI, DWI, or ADC map.

MRI image interpretation

Normal anatomy: On T1-weighted images, the prostate demonstrates homogeneous intermediate-to-low signal intensity, but the soft-tissue contrast resolution is not sufficient for the visualization of intraprostatic anatomy or pathology. The zonal anatomy of the prostate is best seen on high-resolution T2-weightedimages.On T2-weighted images, the peripheral zone demonstrates high signal intensity. The peripheral zone is surrounded by a thin rim of lowT2 signal, which represents the anatomic or true capsule. Low-signal-intensity foci poster lateral to the capsule indicate neurovascular bundles. The central and transition zones are both of lower T2signal intensity than the peripheral zone, and are best differentiated by their respective anatomic locations. The anterior fibro muscular stroma also demonstrates low signal intensity. Unless a catheter is present or a transurethral resection has been performed, the proximal urethra is rarely seen. OnT2-weighted images, the distal prostatic urethra can be seen as a low-signal-intensity ring in the lower prostate. The vas deferens and seminal vesicles demonstrate high signal intensity on T2-weightedimages.On contrast-enhanced MRI, the peripheral zone enhances less than the usually present hyperplasticnodules of the transition or central zone. The contrast resolution is similar to the anatomy seenon T2-weighted images (Brown, 1995; Hricak, 2005; Kurhanewicz, 1996).

Prostate cancer: On T1-weighted images, the prostate demonstrates homogeneous medium signal intensity, and tumors cannot be distinguished. On T2-weighted images, prostate cancer most commonly demonstrates low signal intensity that contrasts with the high signal intensity of the normal peripheral zone. However, low signal intensity in the peripheral zone can also be seen in benign conditions, such as hemorrhage, prostatitis, hyperplastic nodules, or post-treatment changes (Zakian *et al*., 2003; Beyersdorff, 2002).

Future developments: Dynamic contrast-enhanced MRI
MR spectroscopic imaging

Dynamic contrast enhanced MRI: This technique can improve tumour detection and visualisation of capsular penetration (Kurhanewicz, 1996; Zakian, 2003). DCE-MRI provides information about the vessels of the prostate and prostate cancer. Like breast cancer, prostate cancer has increased vascular permeability and interstitial fluid volume and discrimination of prostate cancer is easier in the peripheral zone than in the central gland and transition zone (Beyersdorff, 2002; Wefer, 2000). DCE-MRI/MRSI is not a first-line approach to diagnosing prostate cancer. However, it may be useful for targeted biopsy, especially for patients with PSA levels suggestive of cancer but with negative previous biopsies.

MR spectroscopic imaging: MRSI findings in clinical nomograms improves prediction of cancer extent, thereby improving patient selection for local therapy. Furthermore, as described below, information from MRI/1H MRSI can assist in planning how best to apply the treatment chosen, whether it be surgery or a form of radiation therapy. MRSI are emerging as the most sensitive tools for the anatomical and metabolic evaluation of prostate cancer.(27). MRSI provides a metabolic profile of the prostate gland. The metabolites observed in vivo in the prostate are choline-containing compounds (3.2ppm), polyamines (3.1 ppm), creatine (3.0 ppm), and citrate (a doublet of doublets at 2.5–2.8 ppm).

Conclusion

Prostate MRI uses advanced magnetic resonanace imaging to create very accurate and clear images of the prostate gland .These images diagnostic –quality and especially useful to clinicians when diagnosing prostate cancer disease. Aditionally medical images resulting from the prostate MRI can be combined with the powerful post processing computer programs to provide very detailed information about the prostate .This information can offer a wide variety of diagnosis and treatment options or clinicians and patients. Prostate MRI provides a way for the experts to obtain the best available information that can lead to better diagnosis and patient outcomes. It is a non invasive imaging technique that does not require exposure to ionizing radiation and level of detail makes MRI an invaluable tool in early diagnosis and valuation of tumors and help physicians to evaluate the function as well as the structure of many organs.

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