

Role of Dynamic Contrast Enhanced MRI and  
MR Spectroscopy in Detection of Cancer  
Prostate

*An Essay*

**Submitted For Partial Fulfillment of  
Master Degree in Radiodiagnosis**

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دور تصوير ديناميكية الصبغة عن طريق  
الرنين المغناطيسى والرنين المغناطيسى  
البروتونى الطيفى فى تحديد سرطان

.

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وَقُلْ اَعْمَلُوا فَسَيَرَى اللّٰهُ  
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*Sherif Hasan Abd Alla*

## LIST OF ABBREVIATIONS

Abbreviation	Name
<b>3D</b>	Three-dimensional
<b>Au</b>	Arbitrary unit
<b>BASING</b>	Band selective inversion with gradient dephasing
<b>BPH</b>	Benign prostatic hyperplasia
<b>CC:C</b>	Choline and creatine to citrate
<b>Ch</b>	Choline
<b>Cit</b>	Citrate
<b>CM</b>	Contrast media
<b>Cr</b>	Creatine
<b>CT</b>	Computed tomography
<b>DCE</b>	Dynamic contrast enhanced
<b>DHT</b>	Dihydrotestosterone
<b>DRE</b>	Digital rectal examination
<b>ECE</b>	Extra capsular extension
<b>EES</b>	Extra vascular Extra-cellular space
<b>FOV</b>	field of view
<b>FSE</b>	Fast spin echo
<b>Gd-DTPA</b>	Gadolinium diethylene-triamine-penta-acetic acid
<b>GRE</b>	Gradient-echo
<b>IV</b>	Intra venous
<b>K<sup>trans</sup></b>	Transfer constant
<b>Kep</b>	Out flow kinetic constant
<b>MR</b>	Magnetic resonance
<b>MRI</b>	Magnetic resonance imaging
<b>MRSI</b>	Magnetic resonance spectroscopy imaging

<b>NVB</b>	Neurovascular bundle
<b>PIN</b>	Prostatic intraepithelial neoplasia
<b>ppm</b>	Peak per minute
<b>PRESS</b>	Point-resolved spectroscopy
<b>PSA</b>	Prostatic specific antigen
<b>PZ</b>	Peripheral zone
<b>RP</b>	Radical prostatectomy
<b>s</b>	Second
<b>SE</b>	Spin echo
<b>SI</b>	Signal intensity
<b>SNR</b>	Signal to noise ratio
<b>SV</b>	Seminal vesicles.
<b>T</b>	Tesla
<b>T1 WI</b>	T1 weight image
<b>T2 WI</b>	T2 weight image
<b>TE</b>	Echo time
<b>TNM</b>	Tumor, Nodes, Metastasis
<b>TR</b>	Repetition time
<b>TRUS</b>	Trans rectal ultrasound
<b>TZ</b>	Transition zone
<b>US</b>	Ultrasonography
<b>ve</b>	Percentage of unit volume of tissue

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## Introduction

Cancer prostate is one of the most common malignancies in elderly men. The posterior and lateral aspects of the prostate are the zones in which 70% of cancer prostate arises. Cellular proliferation in the transitional zone results in benign prostatic hyperplasia (*Hricak, et al., 2007*).

The diagnosis of cancer prostate is based on transrectal ultrasonography (TRUS) which is the most commonly used modality for imaging the prostate gland. TRUS enables determination of prostate size and demonstration of the zonal anatomy, and prostate cancer lesions usually appear hypoechoic relative to normal tissue. TRUS has many advantages, including its portability, ease of use, lack of ionizing radiation, low cost, and its capability to perform real-time imaging. Ultimately, however, TRUS is not a high-resolution imaging modality. The capability of TRUS to delineate cancer foci is limited, and its sensitivity and specificity are low, small cancer foci are often not visible at all, and the majority of hypoechoic foci detected by TRUS are not malignant. TRUS is also rarely useful in depicting extracapsular extension of prostate cancer and seminal vesicle invasion, except when gross extension is present (*Hricak, et al, 2007*).

CT is a widely used modality in both the diagnosis and follow-up of nearly all malignancies, but it has only a limited role in the imaging of prostate cancer owing to its poor soft-tissue contrast resolution, which does not allow precise distinction of the internal or external anatomy of the prostate. The major role of CT in patients with prostate cancer is for the detection of bony involvement and in nodal staging; however, CT only detects the enlargement of involved nodes, which is a late finding in patients with prostate cancer (*Ocak, 2007*).

MRI allows anatomical and functional assessment of the prostate. MRI has better soft-tissue resolution than any other imaging method, which enables more-accurate lesion detection and local staging (*Ocak, 2007*).

**Anatomical MRI** of the prostate includes T1-weighted and T2-weighted MRI sequences. On T1W images, the prostate gland appears homogeneous with intermediate low signal intensity, which makes differentiation of the zonal anatomy impossible. T2W images have been widely used for pretreatment work-up for prostate cancer but its accuracy for the detection and localization of prostate cancer is unsatisfactory (*Akin, 2006*).

**Functional MRI** modalities include dynamic contrast enhanced (DCE-MRI), magnetic resonance spectroscopy (MRS) and diffusion-weighted MRI (DW-MRI) (*Ocak, 2007*).

DCE-MRI evaluates the vascularity of tumors by providing quantitative kinetic parameters that reflect the flow of blood and the permeability of the vessels. Fast acquisition sequences, combined with rapid administration of a low-molecular-weight contrast agent, can be used to detect prostate cancer using a two-compartment pharmacokinetic model. DCE-MRI increases the specificity of prostate MRI significantly compared with T2W scans alone (*Ocak, 2007*).

Tumors show early enhancement and early washout of the contrast agent, which enables tumor detection. A disadvantage of DCE-MRI is that small, low-grade tumors may not demonstrate abnormal enhancement on DCE-MRI (*Noworolski, et al., 2008*).

Furthermore, abnormal enhancement patterns can also be seen in patients with benign prostatic hyperplasia (BPH), which can make assessment of the central gland difficult (*Concato, 2007*).

However, in the glandular peripheral zone and anterior gland, DCE-MRI can be quite helpful in identifying lesions that are not suspected on T2W images diagnostic criteria. Another disadvantage of DCE-MRI is the possibility of inducing nephrogenic systemic fibrosis (a severe interstitial fibrosis that occurs after intravenous injection of gadolinium chelates) in patients with severe renal failure, especially those undergoing dialysis; therefore, the use of gadolinium-containing contrast agents should be carefully evaluated in such patients (*Concato, 2007*).

Magnetic resonance spectroscopy (MRS) is a modality that provides information about the cellular metabolites within the prostate gland. It displays the relative concentrations of key chemical constituents, such as citrate, choline and creatine. The normal prostate gland contains low levels of choline and high levels of citrate, whereas prostate cancers have increased levels of choline and decreased levels of citrate. Normal secretory epithelial cells of the prostate contain excess zinc, which inhibits the citrate-oxidizing enzyme aconitase, and high levels of citrate are produced. In prostate cancers, levels of zinc are lower, which leads to elevated aconitase activity and subsequently diminished amounts of citrate (*Costello, et al 2005*).

The high choline levels in prostate tumors are related to increased cell turnover and overexpression of choline kinase. Thus, the ratio of choline to citrate is an index of malignancy. (*Shukla-Dave, 2007*).

Combined use of MRI and MRSI is emerging as the most sensitive tool for the anatomical and metabolic evaluation of cancer prostate. (*Concato, 2007*)

## **Aim of the work**

This work aims to study the role of dynamic contrast enhanced MRI and MR spectroscopy in detection of cancer prostate.