ROLE OF MRI IN DIAGNOSIS AND GRADING OF PROSTATE CARCINOMA

Thesis

Submitted for partial fulfillment of M.D. in Radio-diagnosis

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List of Abbreviations

1- ACQ = Acquired
2- ADC = Apparent diffusion coefficient
3- AS = Active surveillance
4- CG = Central gland
5- CZ = Central zone
6- DCE = Dynamic contrast enhanced imaging
7- DRE = Digital rectal examination
8- DWI = Diffusion weighted imaging
9- ESUR = The European Society of Urogenital Radiology
10- F = Factor
11- FN = False negative
12- FOV = Field of view
13- FP = False positive
14- mp-MRI = Multi-parametric Magnetic resonance imaging
15- MRI = Magnetic resonance imaging
16- MRS = Magnetic resonance spectroscopy
17- N = Number
18- NPV = Negative predictive value
19- PET = Positron emission tomography
20- PI-RADS = Prostate Imaging Reporting and Data System
21- PSA = Prostatic specific antigen
22- PZ = Peripheral zone
23- Sig. = Significance
24- Std. = Standard
25- TE = Time to echo
26- TN = Total negative

27- TP = Total positive
28- TR = Time to repetition
29- TRUS = Trans-rectal ultra-sound guided
30- TZ = Transition zone
31- T2WI = T2 weighted imaging
32- US = Ultra-sound
33- 3D 1HMR = 3 dimensional hydrogen proton magnetic resonance

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Introduction

Prostate cancer is the commonest malignancy and third cause of death in cancer related mortality also its detection rate and treatment have been improved (Hedvig et al., 2007).

Cancer prostate has a spectrum of disease ranging from indolent to aggressive. Many methods of classifying cancer prostate by risk categories have been developed, including pathological staging, prognosis, laboratory findings (e.g., serum prostate-specific antigen [PSA] values), demographics (e.g., age), and physical findings (e.g., digital rectal examination) (Baris et al., 2010).

Radical prostatectomy and radio-therapy, are offered for cases with intermediate to high risk disease, however active surveillance is suggested for cases with clinically low-risk disease (Baris et al., 2010).

Gleason score is accepted and commonly used system for prostate cancer aggressiveness. The D'Amico clinical risk score has been used to provide a better assessment of cancer aggressiveness by adding the Gleason score to the serum PSA value (Baris et al., 2010).

Multi-parametric MR imaging can be used for detection of prostate cancer, and was recommended if cancer is suspected despite negative trans-rectal US and biopsy findings. MR imaging also help in local and distant staging (Hedvig et al., 2007).

The specificity of prostate cancer diagnosis increase when combining T2-weighted pulse sequences with other functional parameters as (diffusion-weighted (DW) imaging , MR spectroscopy and dynamic contrast enhanced MR imaging) reaching from 68% to 87% (Tobias et a.l, 2011).

Prostate cancer diagnosis in DW imaging involves the apparent diffusion coefficient (ADC), which is measured from at least two b values and with lower values in cancerous tissue than normal prostatic tissue(Tobias et al., 2011).

The mean ADC had a negative correlation with Gleason scores. which is mostly due to increased tumor cellular packing, changes of gland stroma structure which becomes fibrous and of disorganized texture resulting in more restricted water molecules motion in high Gleason score cancers. Also, a significant difference is seen between mean ADCs of low, intermediate, and high D'Amico clinical risk tumors (Baris et al., 2010).

Quantitative DW MR imaging is a noninvasive biomarker which is accepted for defining prostate cancer aggressiveness. Mean tumor ADCs inversely correlated to Gleason score. A high accuracy of A z = 0.90 make the ADC a useful biomarker that help improving the identification of patients with a risk of aggressive tumors (Thomas et al., 2011).

MR spectroscopy of the prostate measures three metabolites (choline, creatine, and citrate). The cancer prostate probability increases when the (choline + creatine) / citrate) ratio increase (Tobias et al., 2011).

Dynamic contrast enhanced (DCE) MRI is the commonest imaging method to evaluate vascularity of tumour (Barentsz et al., 2012).

DCE-MRI imaging can be reported in three ways: qualitatively, semi-quantitatively or quantitatively (Barentsz et al., 2012).

DCE-MRI can help in diagnosis, localization, staging and recurrence diagnosis after radical prostatectomy or radiotherapy even in patients with previous negative TRUS-guided biopsy and rising PSA level (Barentsz et al., 2012).

Aim of work:

To evaluate the accuracy of MRI imaging with these four sequences (T2WI, spectroscopy, DWI and contrast enhanced images) in detection and staging of prostatic carcinoma.

Prostate Anatomy

The prostate is fibro-muscular gland shaped as upside-down pyramid, with approximate measurement 4 x 3 x 2 cm, surrounding the prostatic urethra from base of the bladder to the urogenital diaphragm.

The prostate harbors an outer fibro-muscular band, not a true capsule.

Zonal anatomy:

Three anatomical lobes can be recognized after 20 weeks gestation; two lateral lobes and a median lobe.

In the mature gland, the three lobes fuse and the gland is divided into glandular and non-glandular tissue.

Glandular tissue is subdivided into three zones:

1. Central zone or CZ (25% of volume)
    - Wedge-shaped forming base of the prostate.
    - Surrounding the ejaculatory ducts, posterior to prostatic urethra.
2. Transition zone or TZ (5%)
    - Located around the distal part of the prostatic urethra.
    - Benign prostatic hyperplasia arises from the TZ.
3. Peripheral zone or PZ (70%)
    - Cup-shaped enclosing the central and transition zone
    - Prostatic carcinomas arising from the PZ.

Non-glandular tissue forms the most anterior fibro-muscular stroma. (Wijesekera et al, 2012)

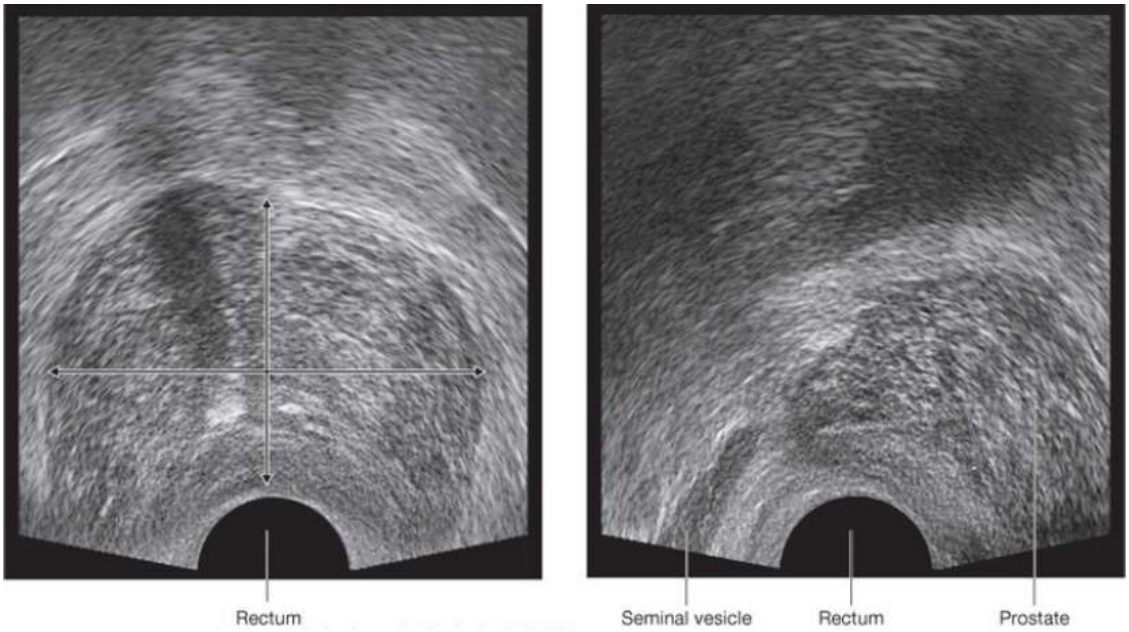

Figure (1.1): Rectal ultrasound imaging of the clinically normal prostate. A) Transverse view. Boundaries of the prostate are indicated by arrows. B) Sagittal view. Seminal vesicle also visible.(Drake et al, 2009)

With aging the periurethral transition zone may hypertrophy, gradually encroaching on the central zone and stretching the peripheral zone , This hypertrophy does not involve the peripheral zone and though only two areas are considered from a radiologic point of view: the central gland (consisting of the hypertrophied transition zone and the compressed central zone) and the peripheral zone. (Villeirs et al., 2005)