

ROLE OF MRI IN DIAGNOSIS AND GRADING OF PROSTATE CARCINOMA

Thesis

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Contents

Subjects	Page
• List of Abbreviations	I
• List of Tables.....	III
• List of Figures.....	IV
• Introduction & Aim of the Work.....	1
• Review of literatures	4
• Material and methods.....	22
• Results	35
• Illustrative cases.....	48
• Discussion.....	93
• Summery	101
• Conclusion	103
• References	104
• Arabic Summary	

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

List of Tables

Table (1.1): Pathological TNM classification for prostate cancer.....	18
Table (2.1): Descriptive Patient characteristics: Numerical data	38
Table (2.2): Frequency and percentage of different pathological stages.....	40
Table (2.3): Frequency and percentage of biopsy-proven Gleason score.....	42
Table (2.4): Comparison between mp-MRI and biopsy-proven pathological results	44
Table (2.5): Mean ADC according to Gleason score.....	46
Table (2.6): Mean ADC value significance within overall groups.....	46
Table (2.6): Multiple comparison between different Gleason scores and ADC values	47

List of figures and images

Figure (1.1): Rectal ultrasound imaging of the clinically normal prostate.....	2
Figure (1.2): Zonal anatomy of the prostate.....	3
Figure (1.3): Central gland changes in prostatic hyperplasia (transverse plane).....	4
Figure (1.4): Transrectal ultrasound of the prostate gland. (A) Transverse image. (B) Longitudinal image.....	6
Figure (1.5): High-resolution MR image of the male pelvis: axial section through the prostate gland.....	8
Figure (1.6): Diagram shows the 24 segments into which the prostate was divided	14
Figure (2.1): PI-RADS classification of T2w: peripheral glandular sections.....	25
Figure (2.2): PI-RADS classification of T2W: central glandular section Diffusion weighted imaging.....	26
Figure (2.3): PI-RADS classification of DWI (high b values and ADC values	27
Figure (2.4) : PI-RADS classification of MRI spectroscopy)	28
Figure (2.5): PI-RADS classification of DCE-MRI, part 1: Curve types.	29

Figure (2.6): PI-RADS classification of DCE-MRI, part 2	29
Figure (3.1): Histogram, normal Q-Q plot of age and observed values for age group	39
Figure (3.2): Different stages frequency included in our study	41
Figure (3.3): Biopsy-proven positive Gleason score frequency included in our study	43
Figure (4.1): T2 axial weighted imaging (case 1)	50
Figure (4.2): Inversed diffusion weighted imaging and ADC maps with the measured ADC values(case 1)	50
Figure (4.3): Spectroscopic imaging showing the post-processed spectroscopic curves(case 1).	51
Figure (4.4): Dynamic contrast enhanced imaging post processing results.(case 2)	54
Figure (4.5): Axial T2 weighted images (case 2)	54
Figure (4.6): Inverted diffusion weight imaging and ADC map (case 2)	55
Figure (4.7): Dynamic contrast enhanced imaging post processing results(case 3)	58
Figure (4.8): Axial T2 weighted images (case 3)	59

Figure (4.9): Inverted diffusion weight imaging and ADC map (case 3).....	59
Figure (4.10): Axial T2 weighted images (case 4).....	63
Figure (4.11): Spectroscopic imaging showing post-processed spectroscopic curves (case 4).....	63
Figure (4.12): color mapping of perfusion imaging (case 4)	64
Figure (4.13): ADC mapping (case 4).....	64
Figure (4.14): Dynamic contrast enhanced imaging post processing results.(case 5).....	68
Figure (4.15): Axial T2 weighted images (case 5).....	68
Figure (4.16): Inverted diffusion weight imaging and ADC map (case 5).....	69
Figure (4.17): Axial T2 weighted images (case 6).....	72
Figure (4.18): Inverted diffusion weight imaging and ADC mapping (case 6).....	73
Figure (4.19): Spectroscopic imaging (case 6).....	74
Figure (4.20): Dynamic contrast enhanced imaging post processing results.(case 7).....	77
Figure (4.21): Axial T2 weighted images (case 7).....	78

Figure (4.22): Inverted diffusion weight imaging and ADC mapping (case 7).....	78
Figure (4.23): Spectroscopic imaging (case 7).....	79
Figure (4.24): Dynamic contrast enhanced imaging with perfusion curve type III on left side of image (case7).....	79
Figure (4.25): Dynamic contrast enhanced imaging post processing results.(case 8).....	83
Figure (4.26): Axial T2 weighted images (case 8).....	83
Figure (4.27): ADC mapping (case 8).....	84
Figure (4.28): Axial T2 weighted images (case 9).....	88
Figure (4.29): ADC mapping (case 9).....	88
Figure (4.30): Spectroscopic imaging showing post-processed spectroscopic curves.....	89
Figure (4.31): Axial T2 weighted (case 10).....	91
Figure (4.32): ADC mapping (case 10).....	92



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 al., 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)

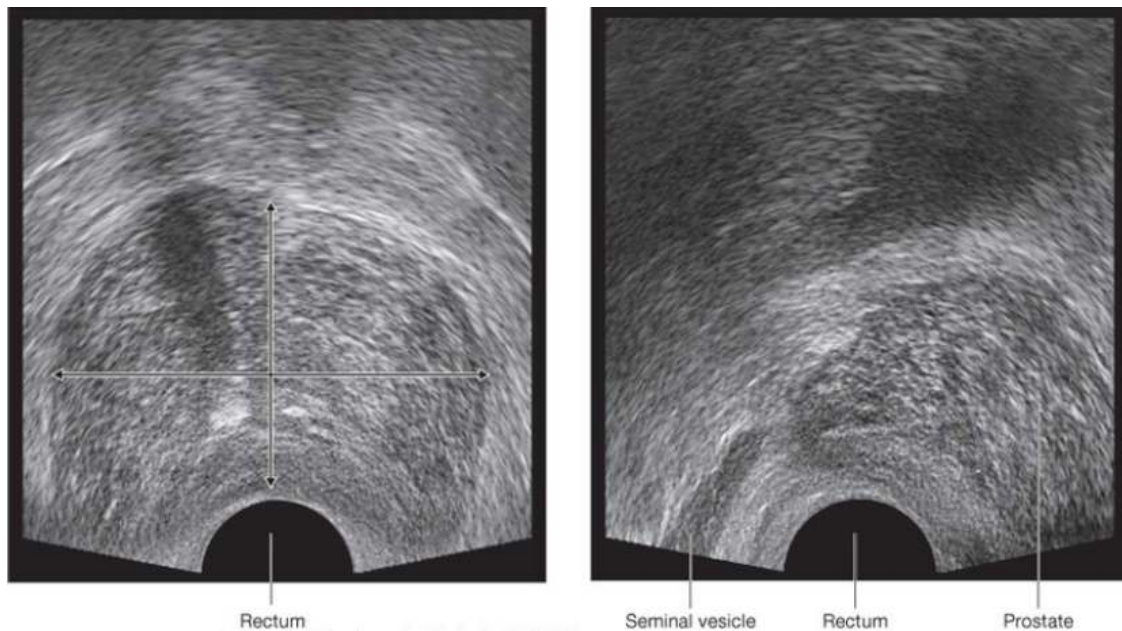


Figure (1.1): Rectal ultrasound imaging of the clinically normal prostate. A) Transverse view. Boundaries of the prostate are indicated by arrows. B) Sagittal view. Seminal vesicle also visible.(Drake et al, 2009)

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)