

ORIGINAL RESEARCH

Prostate Cancer: Comparison Of Apparent Diffusion Coefficient (ADC) Values On MRI With Gleason's Score

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ABSTRACT

Objective: Assess ADC values in prostate cancer and correlate with Gleason score.

Materials and Methods: The study was done in the Department of Radiodiagnosis and Imaging, GMC Srinagar over a period of 18 months with sample size of 30, after ethical clearance from the institutional ethical committee,

Results: Our study showed that mean ADC value of tumors with Gleason's score <6 was significantly different from the tumors with Gleason's score =7 and Gleason's score >7. The difference in mean ADC value of tumors with Gleason's score =7 and Gleason's score >7 were also statistically significant.

Conclusion: Mean ADC values can differentiate between low risk, intermediate risk and high risk tumors. An inverse relationship between ADC values and aggressiveness of tumors with reference to biopsy Gleason score holds true.

INTRODUCTION

Prostate cancer, frequently diagnosed in elderly men, is the most common cancer of this age ^{1,2}. The use of PSA (Prostate Specific Antigen) and DRE (Digital Rectal Examination) is a widely adapted screening program in clinical practice that can efficiently diagnose prostate cancer at earlier asymptomatic stages ^{3,4}. The conventional screening programs have led to an upsurge of unnecessary biopsies and a high risk of over treatment ^{5,6}. For that reason, there is an imminent need for simplified predictive tools that can extend the clinical performance of conventional programs.

Multi-parametric MRI (mpMRI) is presently considered the most sensitive and specific imaging technique to detect prostate cancer as well as its local staging, localization and aggressiveness measurement. MRI has become the method of choice to detect and stage prostate cancer ⁷. Adapted from BI-RADS of breast imaging, PI-RADS (Prostate Imaging Reporting and Data System) was developed.

An mpMRI prostate examination consists of T1 and T2 weighted imaging along with one or more functional MR imaging techniques ^{8,9} including Diffusion Weighted Imaging. DWI is a promising imaging biomarker to detect and characterize prostate cancer.

AIMS AND OBJECTIVES

The aim of this study is to assess ADC (Apparent Diffusion Coefficient) values using DWI MRI in prostate cancer and correlate with Gleason score.

MATERIALS AND METHODS

STUDY DESIGN: The prospective study was conducted in the Post-graduate Department of Radiodiagnosis

and Imaging, Govt. Medical College Srinagar after ethical clearance from the institutional ethical committee.

STUDY SAMPLE: 30 cases

STUDY DURATION: 18 Months

INCLUSION CRITERIA: Patients of any age group with biopsy proven prostate cancer.

EXCLUSION CRITERIA: Patients not giving consent.

- Any contraindication to MRI like patients with pacemakers, claustrophobia, patients with renal impairment etc.

METHODOLOGY

Patients with biopsy documented prostatic cancer admitted in the Department of Urology of GMC Srinagar were included in the study. All MRI studies were performed using 3 Tesla MR System, without endorectal coil, with the following protocol:

Table 1 : MRI protocol					
Sequence	TR/TE (ms)	Slice thickness(mm)	Pixel size (mm)	FOV (mm)	TA (m:s)
Axial high resolution T2w	3710/113	3	0.4 x 0.4	220	4:29
Axial DWI with b-values of 0, 500, 1000, 1500 and 2000 s/mm ²	4700/93	3.5	3.1 x 3.1	160	6:37
Pre-contrast T1w	3.92/1.24	2	1.3 x 1.8	400	0:21
Axial DCE	4.22/1.35	3.5	1.4 x 1.5	220	4:46
Coronal & sagittal high resolution T2w	1500/122	1	1.0 x 1.0	380	7:2
DWI of the entire pelvis with b-values of 0, 500 and 1000 s/mm ²	1030/50	4	3.1 x 3.1	420	5:3
TR = Repetition time, TE = Echo time, FOV = Field of view, TA = Acquisition Time, ms = millisecond, mm = millimeter, m:s = minutes: seconds, DWI = Diffusion weighted imaging, DCE = Dynamic contrast enhanced					

DCE MRI was performed with the contrast agent Gadodiamide (0.5 mmol/ml Omniscan, GE Healthcare) using a dose of 0.1mmol/kg. Pre-contrast T1w sequence is done to exclude hemorrhage.

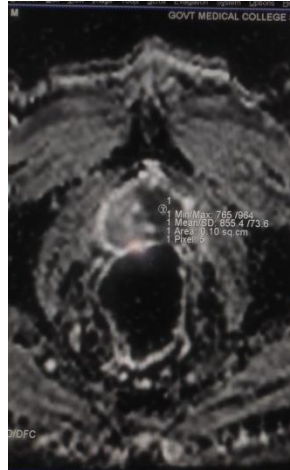


Figure 1: Left Peripheral Zone lesion showing diffusion restriction with ADC value of 0.85×10^{-3} mm²/s. Gleason score of <6 was seen on biopsy

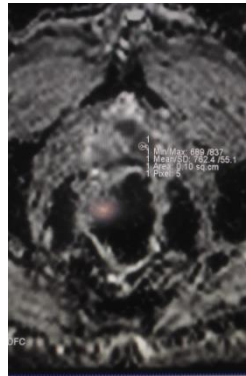


Figure 2: Left Peripheral Zone lesion showing diffusion restriction with ADC value of 0.76×10^{-3} mm²/s. Gleason score of 7 was seen on biopsy

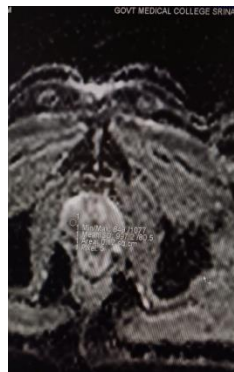


Figure 3: Right Peripheral Zone lesion showing diffusion restriction with ADC value of 0.99×10^{-3} mm²/s. Gleason score of <6 was seen on biopsy

RESULTS

A total of 30 patients were included in the study, with mean age of 58.3 years.

Table 2: Distribution of Gleason Score of the malignancies in TRUS biopsy		
Gleason sum Score	Frequeny	Percentage
9	8	26.6%
8	6	20%
7	9	30%

6	7	23.4%
Total	30	100%

Figure 1. Bar chart depicting distribution of malignancies according to Gleason's score

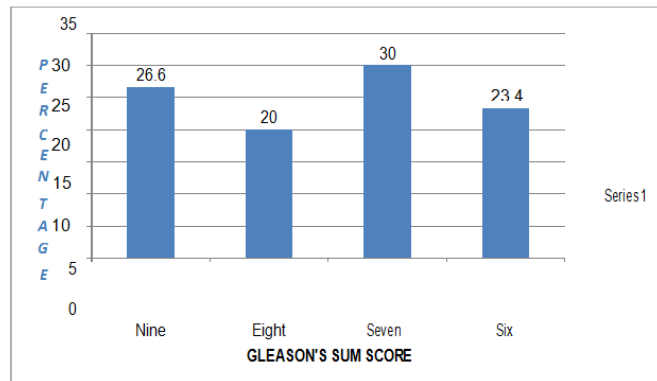


Table 3: Distribution of Participants According To Gleason's Score

Grade	Gleason's score	Frequency	Percentage
Low	≤ 6 (3+3)	7	23.3%
Intermediate	= 7	9	
	(3+4)	4	13.3%
High	(4+3)	5	16.6%
	> 7	14	
	8 (4+4)	3	10%
	(5+3)	3	10%
9	(5+4)	8	26.6%
Total		30	100%

Table 4: Comparison of mean, minimum and maximum tumor ADC values ($\times 10^{-3} \text{mm}^2/\text{s}$) between three Gleason groups

Gleason's Score	Frequency	Mean ADC	Minimum ADC	Maximum ADC	P VALUE
Gleason's score ≤ 6	7	0.89 ± 0.02	0.84	0.92	<0.001
Gleason's score = 7	9	0.79 ± 0.02	0.74	0.84	<0.001
Gleason's score > 7	14	0.70 ± 0.08	0.57	0.81	<0.001

DISCUSSION

Out of the 30 patients, about 7 patients had a Gleason score of 6, 9 had a score of 7 and 14 had a score of 8 & above. Since TRUS (Trans-rectal ultrasound) guided tumor biopsies are invasive and do not accurately

classify Gleason's score in approximately 38% of tumors due to sampling errors, the value of MRI as a non-invasive tool to predict prostate cancer aggressiveness has been under investigation. Diffusion weighted imaging is the only functional imaging technique that evaluates the diffusion of proton molecules. Neoplastic tissues have high cell density with lesser extracellular space, thus decreasing the diffusion of free water molecules, causing restricted diffusion.

In assessing the relationship between ADC value and tumor aggressiveness, we found a significant drop in ADC value with increasing Gleason's score, as also reported by prior studies. This finding suggests an inverse relationship between ADC value and tumor aggressiveness with reference to biopsy Gleason's score. This can be explained by increased cellular density in high grade tumors.

Our study also showed that the mean ADC value of tumors with Gleason's score <6 significantly differed from those with Gleason's score =7 and Gleason's score >7. The difference in mean ADC value of tumors with Gleason's score=7 and Gleason's score >7 were also statistically significant. This suggests that mean ADC value could differentiate between low risk (GS <6), intermediate risk (GS =7) and high risk tumors (GS>7), provided the tumor is visible. In our study, mean ADC for tumors with Gleason's score of <6 was $0.89 \pm 0.02 \times 10^{-3} \text{ mm}^2/\text{s}$, Gleason's score of 7 was $0.79 \pm 0.02 \times 10^{-3} \text{ mm}^2/\text{s}$ and Gleason's score >7 was $0.70 \pm 0.08 \times 10^{-3} \text{ mm}^2/\text{s}$.

In contrast, previous studies assessing the significance of differences in mean ADC values between the three groups had shown variable results. Earlier studies by Yoshimitsu K et al¹⁰ and Woodfield CA et al¹¹ on peripheral zone prostatic cancers showed that mean ADC values could differentiate only the low risk tumors from high risk tumors, but there was no statistically significant difference in mean ADC value between low risk and intermediate risk tumors and between intermediate risk and high risk tumors. Yoshimitsu K et al¹⁰ used pelvic phased array coil for DWI with b values of 0, 800 and 1000 and mean ADC for tumors with Gleason's score of <6 was $1.19 \pm 0.15 \times 10^{-3} \text{ mm}^2/\text{s}$, Gleason's score of 7 was $1.10 \pm 0.24 \times 10^{-3} \text{ mm}^2/\text{s}$ and Gleason's score >7 was $0.93 \pm 0.20 \times 10^{-3} \text{ mm}^2/\text{s}$. Woodfield CA et al¹¹ used endo-rectal coil for imaging with b values of 0 and 1000 and mean ADC for tumors with Gleason's score of <6 was $0.86 \pm 0.04 \times 10^{-3} \text{ mm}^2/\text{s}$, Gleason's score of 7 was $0.70 \pm 0.02 \times 10^{-3} \text{ mm}^2/\text{s}$ and Gleason's score >7 was $0.68 \pm 0.02 \times 10^{-3} \text{ mm}^2/\text{s}$. Yagci AB et al¹² studied peripheral zone prostatic cancer using endo-rectal coil and b values of 0 and 800. The study showed that there was significant decrease in ADC value with increase in tumor grade and mean ADC for tumors with Gleason's score of <6 was $1.18 \pm 0.44 \times 10^{-3} \text{ mm}^2/\text{s}$, Gleason's score of 7 was $1.05 \pm 0.15 \times 10^{-3} \text{ mm}^2/\text{s}$ and Gleason's score >7 was $0.84 \pm 0.16 \times 10^{-3} \text{ mm}^2/\text{s}$.

Luczynska E et al¹³ pelvic phased array coil for imaging with b values of 0, 100, 300, 800 and 1000. The study showed that DWI may help differentiate high grade tumors from intermediate and low grade tumors and mean ADC for tumors with Gleason's score of <6 was $0.85 \pm 0.03 \times 10^{-3} \text{ mm}^2/\text{s}$, Gleason's score of 7 was $0.72 \pm 0.03 \times 10^{-3} \text{ mm}^2/\text{s}$ and Gleason's score >7 was $0.61 \pm 0.04 \times 10^{-3} \text{ mm}^2/\text{s}$. Anwar SS et al¹⁴ also studied peripheral zone prostatic cancer using pelvic phased array coil with b values of 0, 400 and 800 and showed that mean ADC values could differentiate between low risk (GS <6) and high risk (GS >7) tumors and between intermediate risk (GS =7) and high risk (GS >7) tumors. However, the differentiation between low risk and intermediate risk tumors was statistically insignificant. According to this study, mean ADC for tumors with Gleason's score of <6 was $0.93 \pm 0.20 \times 10^{-3} \text{ mm}^2/\text{s}$, Gleason's score of 7 was $0.83 \pm 0.12 \times 10^{-3} \text{ mm}^2/\text{s}$ and Gleason's score >7 was $0.57 \pm 0.15 \times 10^{-3} \text{ mm}^2/\text{s}$. All these studies were conducted on a 1.5 Tesla MR, but using different b values and imaging parameters for DWI with or without endorectal coil, which could be the cause of discrepancies in results between the various studies.

Conclusion

Mean ADC values can differentiate between low risk, intermediate risk and high risk tumors. An inverse relationship between ADC values and aggressiveness of tumors with reference to biopsy Gleason score holds true.

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