Original Article

DOI: 10.4274/uob.galenos.2022.2022.4.2

Bull Urooncol 2023;22(1):28-34

Apparent Diffusion Coefficient Values as a Complementary Tool in Prostate Gland Disease: Retrospective Evaluation of Apparent Diffusion Coefficient Values with Pathological Data Guided by PI-RADSv2.1

Gülşen Yücel Oğuzdoğan[1], Zehra Hilal Adıbelli[2], Ertuğrul Şefik[3], Fatma Zeynep Arslan[1]

[1]*University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital, Clinic of Radiology, İstanbul, Turkey*
[2]*University of Health Sciences Turkey, İzmir Bozyaka Training and Research Hospital, Clinic of Radiology, İzmir, Turkey*
[3]*İzmir Tınaztepe University Faculty of Medicine, Department of Urology, İzmir, Turkey*

Abstract

Objective: This retrospective study reveals whether a lesion is a benign pathological process or malignant by measuring apparent diffusion coefficient (ADC) values following prostate imaging reporting and diagnostic system version 2.1 (PI-RADSv2.1) guide on multiparametric magnetic resonance imaging (MpMRI) examinations. Furthermore, this study aims to determine the cut-off ADC values (ADCv) that may exist to help identify and distinguish between benign and the malignant lesions. Additionally, the paper evaluates whether there is a correlation between malignant lesions' International Society of Urological Pathology (ISUP) score and ADCv, and whether ADCv provide information about prostate cancer (PCa) aggressiveness without requiring invasive procedures.
Materials and Methods: The study group consised of 243 patients. The lesions were diagnosed using transrectal ultrasound-guided cognitive MRI fusion. MpMRI images before the biopsy were evaluated according to PI-RADSv2.1 guideline by a radiologist. Three groups, benign prostatic tissue, prostatitis, and PCa were obtained according to the histopathological results.
Results: When the cut-off value for ADC was $780x10^{-3}$, sensitivity was 80%. When the cut-off value was taken as $668x10^{-3}$, the sensitivity and specificity were 72% and 62%, respectively. When the cut-off ADCv was taken as $647x10^{-3}$, the sensitivity was 83% and the specificity was 48.5%. ADCv varied significantly depending on the ISUP groups (p=0.003). It was determined that the ISUP 1 group was significantly higher compared to other groups. ADC group mean values were not significantly different between groups 2, 3, 4, and 5.
Conclusion: ADCv may be a suitable tool for estimating PCa aggressiveness, and it shows a significant potential to improve the diagnostic accuracy.
Keywords: Prostate cancer aggressiveness, magnetic resonance imaging, apparent diffusion coefficient value, PI-RADSv2.1

Introduction

Prostate cancer (PCa) shows a broad spectrum, ranging from low-grade organ-confined tumors to aggressive tumors that can metastasize and lead to death. Therefore, proper diagnosis and staging are essential (1). There are several treatment options for PCa, such as emergency radical surgery, hormonotherapy, and active surveillance (2). However, different treatments have different effects on the patients. For example, radical treatment decreases the quality of life with the risks of incontinence and impotence. The difficulty of managing PCa is to distinguish clinically significant cancers that should receive a radical treatment from clinically insignificant (3).

Multiparametric magnetic resonance imaging (MpMRI) has become the basic non-invasive examination for evaluating of the prostate gland (4,5,6). Diffusion-weighted imaging (DWI) is the basic sequence in MpMRI protocols in addition to conventional sequences, because it has advantages such as short exposure time, rapid acquisition, and creation of qualitative and quantitative measurements on apparent diffusion coefficient (ADC). The ADC value (ADCv) is a quantitative parameter of DWI representing water diffusion in the extracellular and extravascular spaces and capillary perfusion, also it has been shown to be decreased in malignant lesions. DWI is also the main sequence in the evaluation of peripheral zone (PZ) lesions,

Cite this article as: Oğuzdoğan GY, Adıbelli ZH, Şefik E, Arslan FZ. Apparent Diffusion Coefficient Values as a Complementary Tool in Prostate Gland Disease: Retrospective Evaluation of Apparent Diffusion Coefficient Values with Pathological Data Guided by PI-RADSv2.1. Bull Urooncol 2023;22(1):28-34.

Address for Correspondence: Gülşen Yücel Oğuzdoğan, University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital, Clinic of Radiology, İstanbul, Turkey
Phone: +90 505 827 63 95 **E-mail:** gulsenyuceloguzdogan@gmail.com **ORCID-ID:** orcid.org/0000-0002-6762-6820
Received: 20.04.2022 **Accepted:** 16.06.2022

and its contribution to the final prostate imaging reporting and data system (PI-RADS) score in the transitional zone (TZ) has increased with the updated PI-RADS version 2.1 (PI-RADSv2.1) guide published in 2019 (7). To evaluate MpMRI data more accurately and objectively, this study suggests determining ADCv in addition to the visual signal assessment suggested in the PI-RADSv2.1. As we believe, this process can significantly contribute to standardize reporting results. Prior studies have reported that ADC cut-off values can be used as a diagnostic tool showing malignancy risk and tumor aggressiveness of focal lesions (8,9).

This retrospective study aims to reveal whether the lesion is benign or malign by measuring ADCv following PI-RADSv2.1 guide on MpMRI examinations and transrectal ultrasound (TRUS) guided cognitive fusion biopsy (CF-Bx). Additionally, the study evaluates whether there is a correlation between malignant lesions' pathological grade [International Society of Urological Pathology (ISUP) score] and ADCv and whether ADCv provide information about PCa aggressiveness without requiring invasive procedures. We determined the cut-off ADCv that may exist to identify and differentiate between benign and malignant lesions and to distinguish between cancers with an ISUP score ≥2 and with an ISUP score 1.

Materials and Methods

This retrospective study included 243 patients that were referred to the Radiology Clinic due to their elevated prostate-specific antigen (PSA) value (ng\mL) during the follow-up or positive digital rectal examination, or family history of PCa, MpMRI for PCa diagnosis and, screening between April 2019 and April 2020. There is no random selection of patients since we included all the male patients that were referred to radiology clinic for the above-mentioned complications or procedures. The ethical approval was obtained from the University of Health Sciences Turkey, İzmir Bozyaka Training and Research Hospital Clinical Research Ethics Committee (decision no: 2021/199, date: 24.11.2021).

The inclusion criteria were to have a PI-RADSv2.1 score ≥3 lesion and to be examined by MRI-TRUS CF-Bx after MpMRI. Fifty-three patients who have PI-RADS <3 lesions; 15 patients with unsuitable image quality due to persistent rectal gas distension; 30 patients with bx performed previously, without CF-Bx in our hospital and with PCa treatment before testing; 10 patients with no tissue diagnosis due to refusing biopsy were excluded from the study. Finally, 135 patients and 152 lesions with a PI-RADSv2.1 score ≥3 were found eligible for our study, and they were diagnosed with MRI-TRUS CF-Bx in our urology clinic.

MRI Protocol

Prostate MpMRI images examined in the study were performed with a 1.5T Siemens Magnetom Aera (Siemens Healthcare, Erlangen, Germany) MRI device with 18 channels (body 18 A 1.5T Tim Coil) pelvic coil is used. DWI was obtained in the axial plane using 4 different b-values before contrast administration (b: 50-800-1200-1800 sec/mm^2). The b-2000 value was calculated and generated by the device itself, and the ADCv was calculated with a monoexponential model on a pixel-pixel basis using all b values. ADCv was obtained quantitatively from ADC maps. Different b-value distributions were applied which vary between 50 and 1800 sec/mm^2.

Evaluation of Images and Histopathological Correlation

MpMRI images were evaluated on the SYNGO.VIA workstation before biopsy according to PI-RADSv2.1 guideline by a radiologist with 5 years of experience in MpMRI evaluation. Patient age (years), serum PSA values (ng\mL), PSA density (PSAd) (ng/mL/cc), and prostate volume (cc) were recorded. The lesions in the TZ and PZ were scored according to the PI-RADSv2.1 guideline. All lesions with a PI-RADSv2.1 score ≥3 were included in this study. Localization, the largest diameter, and PI-RADS score of the tumors were recorded. The assessing radiologist chose the best suited ADC map image for each lesion and measured the ADCv of the lesions. Measurements were made retrospectively using an elliptical or circular region of interest (ROI) tool available on the SYNGO.VIA workstation using a field of view adjusted to prostate imaging from lesions and for comparison, measurements were taken avoiding borders in the parenchyma areas that appear homogeneous in all sequences without lesions in the PZ and TZ. The average of the measured ROI area was 15 mm2 (8 pixels). Measurements were performed twice for both PZ-TZ parenchyma and each lesion, and the lowest ADCv was used for the evaluation. In the radiology report, ADCv was defined as millimeter^{2}x10^{-3} per second. Relationships between patient age, serum PSA level, tumor ADCv, and Gleason score (GS) were investigated. Lesions with pathologically GS ≥6 were accepted as malignant. In our hospital, MRI-TRUS CF-Bx, 18G automatic tru-cut biopsy needle, and hypoechogenic-hyperechogenic foci were also considered and correlated with the foci identified in the MpMRI obtained before biopsy and marked on the sector map, and two samples were made from each lesion by 15 years experienced urologist. The radiologist and urologist made a consensus to decide the localization of the lesion together during the biopsy. Histopathological analysis of prostate specimens was performed by a urological pathologist with 20 years of experience. Three groups, which are benign prostatic tissue, prostatitis, and prostate cancer, were obtained according to the histopathological results. The malignant lesions were grouped according to the ISUP criteria (ISUP1, GS3+3; ISUP2, GS3+4; ISUP3, GS4+3; ISUP4, GS4+4; ISUP5, GS ≥9) (10).

Statistical Analysis

In the descriptive analysis, continuous variables are presented as mean ± standard deviation or median (25-75th percentile), and categorical variables as a percentage (%). The compliance of the data to the normal distribution was evaluated using the Shapiro-Wilk test. When the distribution of the data was normal, the t-test was used in the comparison of the two groups, and the Mann-Whitney U test was used under non-parametric conditions. One-way ANOVA or non-parametric Kruskal-Wallis test was used to compare continuous variables between three and more categories. The strength of the correlation between two continuous variables was evaluated using the Spearman correlation analysis. Accordingly, the correlation coefficient (r) values <0.2 show feeble or no correlation, values from

0.2-0.4 show weak correlation, from 0.4-0.6 show moderate correlation, 0.6-0.8 show a high correlation, and values >0.8 are interpreted as very high correlation. Receiver operating characteristic analysis was used to evaluate the success of the obtained variables in diagnosing PCa and to determine the cut-off values, and the area under the curve (AUC), sensitivity, and specificity were calculated. After confirming that the data were normally distributed, unpaired t-tests were used to determine significant differences in mean ADCv between normal and cancer regions in the prostate gland according to zones. The relationships between ADCv and tumor's GS were evaluated using the Spearman rank correlation coefficient (").

SPSS 22.0 (founded by SPSS Inc. in the USA) and MEDCALC (developed by Medcalc Software in 1993) programs were used for the statistical analysis. $p<0.05$ was considered statistically significant. Data are shown as mean ±95% confidence interval (CI).

Results

A total of 135 patients and 152 lesions were included in this study. The mean age of the patients was 63.7±7.12. The mean PSA values (ng\mL), prostate volume (cc) and PSAd (ng/mL/cc) of the individuals are 9.78±14, 65.83±35.07, 0.24±0.39, respectively. In the PI-RADS groups 3, 4, and 5, there were 84, 39, and 29 lesions identified respectively, and the PCa prevalence of them was 24.2%, 60%, and 93.4% respectively. Forty (26.3%) of 152 lesions obtained from individuals were diagnosed as benign prostatic tissue, 55 (36.2%) prostatitis, and 57 (37.5%) of them were diagnosed with PCa (Table 1). Sixteen lesions were identified as ISUP1 and 41 of the lesions had higher ISUP grades.

When PCa-non-PCa lesions and PCa-prostatitis lesions were evaluated according to age, PSA, prostate volume, and PSAd; the mean PSA values were not statistically different (p=0.051 and p=0.256). Mean age and PSAd were higher in the PCa group, and the prostate volume was lower (Table 1). Age showed a low-level positive correlation (r=0.308, p=0.004) with the mean PSA. While a weak positive correlation between PSA and prostate volume (r=0.275, p=0.011); a moderate positive correlation (r=0.617, p<0.001) was observed with the PSAd. A moderate negative correlation was found between prostate volume and PSAd (r=-0.502, p<0.001).

The mean ADCv for the normal PZ was 1174.22±178.19x10^{-3} [minimum-maximum (min-max): 739.0-1537.0x10^{-3}], the mean ADCv for the normal TZ was 920.27±158.27x10^{-3} (min-max: 312.4-1521.0x10^{-3}) (Graphic 1). While there was a weak negative correlation between PZ ADCv and PSAd (r=-0.236, p=0.036), a weak positive correlation was observed between TZ ADCv and PSAd (r=0.326, p=0.003).

When cancer and non-cancerous lesions were compared, ADCv were found to be significantly different (Table 2). Mean ADCv for pCa were 598.8±145.3 x10^{-3} and Mean ADCv for non-pCa were 758.9636±146.4 x10^{-3}.

When the mean ADCv of the malignant lesions according to the zones are evaluated, it is 629.97±151.77 for the PZ and 614.75±152.23 for the TZ, and the difference between them is not statistically significant (p=0.830) (Table 3). ADCv of benign prostatic tissue, prostatitis, and PCa groups showed a statistically significant difference (p=0.001).

To determine the group in which the difference originated, paired comparisons were made. No significant difference was found between the benign prostatic tissue and prostatitis group ADCv (p=0.076).

Table 1. Descriptive statistics of patients who have PCa or nonPCa or prostatitis

Variables	PCa positive n=51	non-PCa n=84	Prostatitis n=59	p-value	p-value*
Age (years) Mean ± SD	65.23±7.8	62.06±6.90	61.41±7.04	0.051	0.048
PSA (ng/mL) Median (25p-75p)	7.36 (5.23-11.16)	7.22 (4.20-9.76)	9.96 (4.77-11.19)	0.250	0.256
Prostat volume (cc) Median (25p-75p)	40.37 (31.00-51.23)	71.50 (44.85-99.75)	74.75 (44.90-102.0)	<0.001	0.003
PSA density (ng/mL/cc) Median (25p-75p)	0.21 (0.11-0.33)	0.10 (0.07-0.147)	0.11 (0.08-0.13)	<0.001	0.012
ADC Median (25p-75p)	544.50 x10^{-3} (485.0-727.83)	679.48 x10^{-3} (620.8-812.5)	788.39 x10^{-3} (663.05-905.25)	0.003	<0.001

P-value refers to comparison in between PCa and non-PCa, p-value* refers to comparison in between PCa and prostatitis
p and p* values were calculated using independent t-test for age;
p and p* values were calculated using the Mann-Whitney U test for the others
Prostate Volume and PSAd values are statistically significant for PCa and prostatitis lesion differentiation
PCa: Prostat cancer, n: Number of lesions, SD: Standard deviation PSA: Prostate spesific anjigen, PSAd: PSA density, ADC: Apparent diffusion coefficient

Table 2. Mean ADC values according to the pathological diagnosis

Pathological definitive diagnosis					
Variables		**Benign prostatic tissue (n=40)**	**Prostatitis (n=55)**	**PCa (n=57)**	**p-values**
ADC	**Mean ± SD**	707.34±131.04 x10^{-3}	790.51±148.15 x10^{-3}	598.82±145.35 x10^{-3}	<0.001
	Median (25p-75p)	679.48 x10^{-3} (608.00-820.76)	788.39 x10^{-3} (663.05-905.25)	544.50 x10^{-3} (485.0-727.83)	

ADC: Apparent diffusion coefficient, PCa: Prostate cancer, n: Number of lesions, SD: Standard deviation, p-value less than 0.05 considered as statistically significant. P-values were calculated using Kruskal-Wallis test

The ADCv of the PCa lesions (598.82±145.35 x10^{-3}) were found to be significantly lower than the prostatitis group (790.51±148.15 x10^{-3}) (p=0.011) and the benign prostatic tissue group (707.34±131.04 x10^{-3}) (p≤0.005). AUC is 0.796 (0.702-0.890) for the ADCv in diagnosing PCa, (p<0.001).

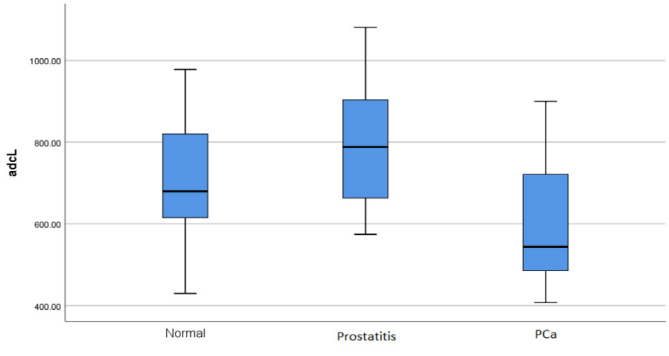
When the cut-off value for ADC was 780x10^{-3}, sensitivity was 80% and specificity was 45.5%. When the cut-off value was taken as 668x10^{-3}, the sensitivity was found to be 72% and specificity 62%. When the cut-off value was taken as 633.7 x10^{-3}, the sensitivity was found to be 70.5% and specificity 80.7%. AUC was 0.775 (0.686-0.864), p<0.001 for ADCv in diagnosing prostatitis. When the cut-off ADCv was taken as 647x10^{-3}, the sensitivity was 83% and the specificity was 59,4%. When the cut-off ADCv was taken as 697.5 x10^{-3}, the sensitivity was 64.9% and the specificity was 67.2%. When the cut-off value for ADC was 773x10^{-3}, the sensitivity was 53% and specificity was 75.0% (CI was 95%) (Graphic 2,3,4).

ADCv varied significantly according to the ISUP groups (p<0.001). In paired comparisons, it was determined that ISUP 1 group was significantly higher than each other group (Graphic 4). The cut-off value for ADC was found to be 584.59 to distinguish the ISUP grade 1 from >1 [sensitivity, 81.3%; specificity, 92.6%, AUC (95% CI): 0.863 (0.734-0.993)]. ADC group mean values were not significantly different between group 2, 3, 4, and 5 (Table 3, Figure 1,2).

Table 3. The Asssociation between ADC values and ISUP grades

	ISUP	Mean ± SD	p-value
ADC	1 (n=16)	726.71±143.08 x10^{-3}	0.003
	2 (n=9)	558.03±132.98 x10^{-3}	
	3 (n=10)	496.21±73.69 x10^{-3}	
	4 (n=12)	508.67±27.94 x10-^{3}	
	5 (n=10)	527.16±63.48 x10^{-3}	

ADC: Apparent diffusion coefficient, ISUP: International Society of Urological Pathology, SD: Standard deviation, p-value less than 0.05 considered as statistically significant



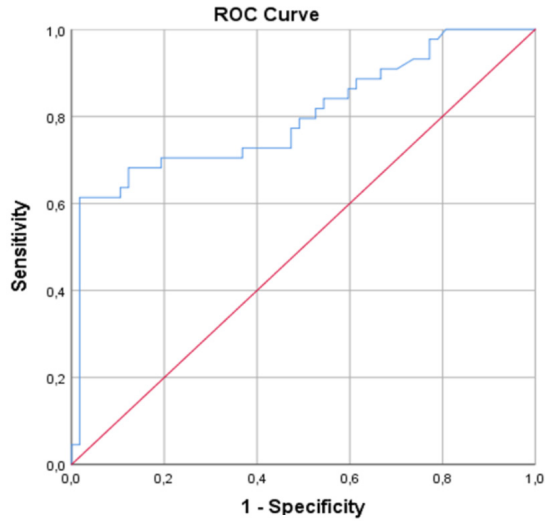
Graphic 1. Distribution of ADC values of pathological results in the prostate gland

The mean ADC value for the normal peripheral zone is 1174.22±178.19 x10^{-3} (min-max: 739.0-1537.0 x10^{-3}), the mean ADC value for the normal transitional zone is 920.27±158.27 x10^{-3} (min-max:312.4-1521.0 x10^{-3})

ADC: Apparent diffusion coefficient, Min-max: Minimum-maximum

Discussion

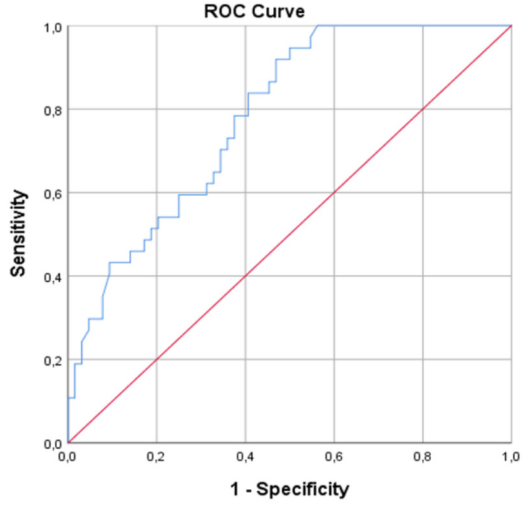
PCa itself is a disease with a very heterogeneous clinical course, 5-year survival ranging from 100% to 29% for the localized disease (11,12,13). The ISUP score is a widely accepted histopathological grading system for PCa, it reveals a 5-year survival rate of patients after radical prostatectomy (10).



Graphic 2. ROC curves of ADC values that showed for PCa

The cut-off value for ADC was found for 780x10^{-3} (sensitivity 80%, specificity 45.5%); for 668x10^{-3} (sensitivity 72%, specificity 62%); for 633.7x10^{-3} (sensitivity 70.5%; specificity 80.7%), AUC (95% CI): 0.796 (0.702-0.890) for PCa (p<0.001)

ROC: Receiver operating characteristic, ADC: Apparent diffusion coefficient, PCa: Prostate cancer, CI: Confidence interval, AUC: Area under the curve



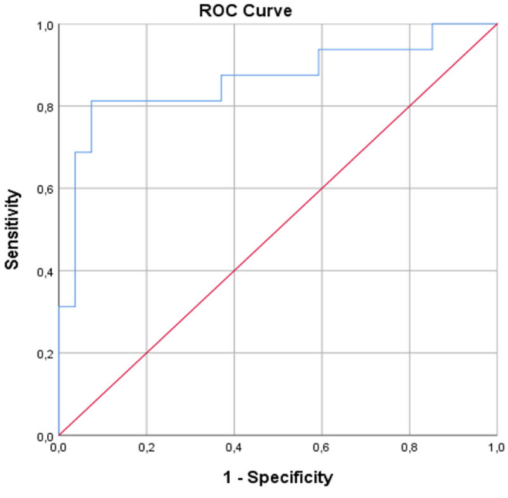
Graphic 3. ROC curves of ADC values that showed for prostatitis

The cut-off value for ADC was found for 647 x10^{-3} (sensitivity 83%, specificity 59.4%); for 697.5x10^{-3} (sensitivity 64.9%, specificity 67.2%); for 773x10^{-3} (sensitivity 53%; specificity 75%), AUC (95% CI): 0.775 (0.686-0.864) for prostatis (p<0.001)

ADC: Apparent diffusion coefficient, CI: Confidence interval, ROC: Receiver operating characteristic, AUC: Area under the curve

Differentiating a low-grade (ISUP-1) tumor, which is not expected to have a significant effect on 5-year survival, from significant (ISUP 2-5) PCa, may decrease prebiopsy and pretreatment risk stratification of the patient (14). It will save the patient from the morbidities of radical prostatectomy that decrease the quality of life e.g., incontinence, especially in very elderly patients, and may lead the clinician to prefer more conservative treatments. It is a delicate balance to be able to distinguish between PCa cases that do not require any intervention and patients who will undergo radical treatment, and it can only be established using the correct auxiliary modalities. Advances in the MpMRI technique increase the diagnostic accuracy in detecting clinically significant PCa (15).

DWI and ADC are two important milestones in PI-RADSv2.1 for evaluating the PZ, where PCa is the most common, and TZ (16). It is a known fact that highly cellular cancers have smaller interstitial space and lower ADCv (17). The healthy prostate tissue observed in the PZ of the prostate contains rich tubules and allows the diffusion of the water. ADCv is high in this area. On ADC maps, lower ADCv are detected because PCa destruct the normal tissue and invades the ducts of the gland (18). Several previous studies have revealed that ADCv is negatively correlated with GS and may show PCa aggressiveness (19,20). However, absolute ADCv varies considerably depending on individual factors such as selected b-values and patient demographics (21). There is no consensus on the cut-off ADCv in distinguishing PCa from healthy parenchyma. Also, no agreed ADCv correspond to the ISUP grades. However, a range between 750-900 mm^2/s is suggestive for PCa in PI-RADSv2 (22). The mean ADCv of the lesions included in our study was 629.97±151.77 for the PZ and 614.75±152.23 for the TZ. Currin et al. (23) reported that malign cells within the aggressive PCa produce duct and acini and pushing normal prostatic secretions and have marked nucleomegaly, this may be the reason for ISUP 2 or 3 tumors to demonstrate the characteristic features of high-risk PCa on MRI. Wu et al. (24) revealed that higher ADCv ($0.830x10^{-3}$ mm^2/s) was related to low-risk PCa (GS 6 disease). Alessandrino et al. (13) found that quantitative values obtained from ADC (median ADC, and ADC ratio) are inversely correlated with the ISUP score. In another study, ADCv can distinguish GS 6-7 PCa from 8-10, but there was no statistical difference between GS 3+4 and 4+3 PCa (25). Hambrock et al. (26) found that ADCv can perfectly differentiate low-grade vs intermediate grade vs high-grade PCa from each other. In another study, ADCv reduced the false-negative rate of MpMRI (PI-RADS <3) for clinically significant PCa (27). In a meta-analysis in which Shaish et al. (28) evaluated the studies on ADCv recently published in the literature; 13 studies were included, providing 1107 tumor foci in 705 patients. They reported that ADCv demonstrates moderate accuracy in distinguishing clinically significant PCa from insignificant. They further reported that a significant bias may occur in these studies, therefore the performance of ADCv in distinguishing high-grade cancers from low-grade cancers may have been exaggerated, and that there was substantial heterogeneity in the results. In fact, the results of our study also support this broad meta-analysis. In paired comparisons, it was determined that the ISUP 1 group was significantly higher than each of the other group. Mean ADCv did not show a statistically significant difference between groups 2, 3, 4, 5. Our study shows that ADCv are successful in distinguishing cancers with an ISUP 1, which are defined as silent diseases, from cancers with a clinically important (ISUP ≥2). Thus, in elderly patients



Graphic 4. The cut-off value for ADC was found to be 584.59 for ISUP grade 1

ADC: Apparent diffusion coefficient, ISUP: International Society of Urological Pathology, ROC: Receiver operating characteristic

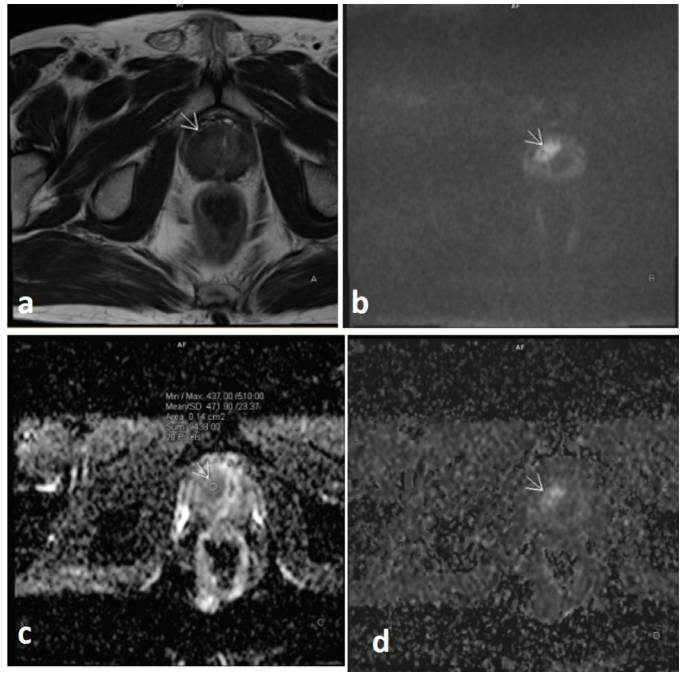


Figure 1. A 68-year-old male patient whose serum PSA level was 6.7 ng/mL. (a) On the T2W axial view; a prominent hypointense lesion (17x12x10 mm in size) located in the right middle part of the peripheral zone is seen. (b) on DWI axial image (b=1800 s/mm^2); lesion is markedly hyperintense, (c) ADC map shows markedly hypointense lesion and ADC value measured as $471.90x10^{-3}$ mm^2/s. (d) on DWI axial image (b=2000 s/mm^2); lesion is markedly hyperintense. Lesion evaluated as PI-RADS score=5 and histopathologically confirmed as ISUP grade 5 PCa

PSA: Prostate-specific antigen, ADC: Apparent diffusion coefficient, DWI: Diffusion-weighted imaging, PI-RADS: Prostate imaging reporting and diagnostic system, ISUP: International Society of Urological Pathology, PCa: Prostate cancer

where radical prostatectomy will not change the 5-year survival rate, with a simple measurement of ADCv, we can predict clinically insignificant (ISUP 1) PCa before surgery. And we can protect these patients' groups from the possible morbidity of radical prostatectomy, such as incontinence, by choosing a more conservative treatment plan. In a recent study, Sokmen et al. (29) found that the ADC coefficient of variation value as a tissue texture parameter can be a new biomarker to assess tumor aggressiveness in patients with PCa.

The effectiveness of ADCv in differentiating PCa from benign processes is known fact. In our study, when PCa and non-cancerous lesions were compared, ADCv was significantly different. DWI and ADC mapping demonstrated that the tissue cellularity of the prostate parenchyma are basic sequences that can provide vital information. Threshold values are enabled us to distinguish between prostatitis and benign lesions, and these values can be obtained with ADC mapping since it reflects the internal architecture and localization of the pathological process within the prostate (30). PCa and chronic prostatitis are associated with variable clinical manifestations and presentation may interfere. Unfortunately, there are no specific diagnostic laboratory tests to distinguish them from each other (31). In another study, the accuracy of MRI was observed in the differentiation of PCa from other prostatic disorders, such as benign prostatic hyperplasia, acute bacterial prostatitis, and chronic bacterial prostatitis. The sensitivity to differentiate PCa from benign disorders was high, but they found that the accuracy of detecting bacterial prostatitis was low compared with other prostatitis groups (32). Prostatitis has two forms known as acute and chronic prostatitis. Low signal intensity on T2-weighted images and early enhancement on dynamic MRI is both observed in PCa and prostatitis. Esen et al. (31) reported that ADCv is highly effective in differentiating PCa from prostatitis, but there was no significant difference between normal prostate parenchyma and prostatitis.

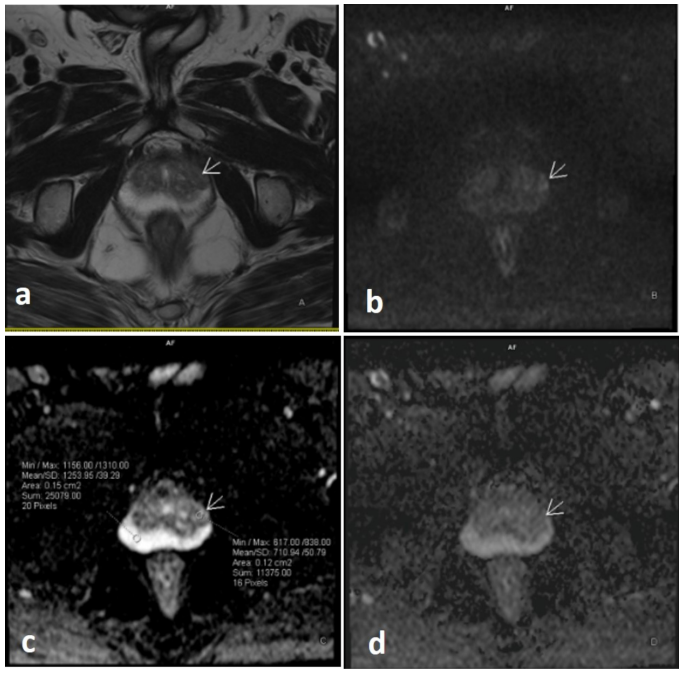


Figure 2. A 55-year-old male patient whose serum PSA level was 5.6 ng/mL. (a) On the T2W axial view; a prominent hypointense lesion (7x8x10 mm in size) located in the left middle part of the peripheral zone is seen. (b) on DWI axial image (b=1800 s/mm^2); lesion is mildly hyperintense, (c) ADC map shows markedly hypointense lesion and ADC value measured as 710,94x10-^{3} mm^2/s. (d) on DWI axial image (b=2000 s/mm^2); there is no abnormal signal. Lesion evaluated as PI-RADS score=3 and histopathologically confirmed as ISUP grade 1 PCa

PSA: Prostate-specific antigen, DWI: Diffusion-weighted imaging, ADC: Apparent diffusion coefficient, PI-RADS: Prostate imaging reporting and diagnostic system, ISUP: International Society of Urological Pathology, PCa: Prostate cancer

Similarly, in our study, no significant difference was found between benign prostatic tissue and prostatitis group ADCv, but a significant difference was observed between normal prostate tissue and benign prostate disease ADCv as well as between normal prostate tissue and PCa.

Study Limitations

Our study had some limitations; first, the reference ADCv did not investigate different b-values. In our study, only the most preferred b-values in the routine were used and, normal ADC reference values were not compared according to the b-value used. It is left for further studies to investigate its effect. The significant disadvantages of TRUS-guided CF-Bx are that success rates are highly dependent on the operator's experience and lack of standardization (12). In our study, the false-negative rate of TRUS-guided CF-Bx, especially in clinically insignificant tumors, was not considered. This present study was performed with one type and a 1,5T MRI. Other manufacturers' devices should be investigated and compared. Also, interobserver variability was not evaluated in our study, and we suggest a larger scale of a prospective study to be conducted.

Conclusions

In conclusion, ADCv is a potent and non-invasive imaging method that can provide useful information about the tissue structure in the prostate parenchyma. Creating a reference range for pathological ADCv accepted by all radiologists in the differentiation of PCa from normal prostate parenchyma and prostatitis is also promising and has become a necessity. ADCv can be used as a complementary imaging method for clinically distinguishing insignificant PCa from significant tumors. Considering the presence of operator-dependent false-negative results in TRUS-guided biopsy and CF-Bx, particularly in the elderly patient group, demonstrating clinically insignificant PCa before surgery with accuracy may protect this patient group from possible complications of radical prostatectomy. Also, in distinguishing PCa from normal prostate parenchyma and prostatitis, ADCv shows significant potential and may improve the diagnostic accuracy. Similar to our study, the importance of ADCv has been shown in the latest version of PI-RADS, and we believe that ADCv should be used in the upcoming version of the PI-RADS.

Acknowledgements

Publication: The results of the study were not published in full or in part in form of abstracts.

Contribution: There is not any contributors who may not be listed as authors.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

Ethics

Ethics Committee Approval: The ethical approval was obtained from the University of Health Sciences Turkey, İzmir Bozyaka Training and Research Hospital Clinical Research Ethics Committee (decision no: 2021/199, date: 24.11.2021).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: G.Y.O., E.Ş., Concept: G.Y.O., Design: Z.H.A., Data Collection or Processing: G.Y.O., Analysis or Interpretation: E.Ş., Literature Search: G.Y.O., Writing: G.Y.O., F.Z.A.

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