

The Role of Diffusion Weighted Magnetic Resonant Imaging in the Diagnosis of Malignant and Benign Urinary Bladder Lesions

Amna Rehan¹, Zeghum Hussain², Nosheen Ahmad³, Abdul Raouf⁴, Hassan Bukhari⁵

- 1 Assistant Professor, Radiology Department, Faisalabad Medical University / Allied Hospital, Faisalabad Pakistan
Concept of the research, Manuscript writing
- 2 Medical Officer, Department of Radiology, Allied Hospital, Faisalabad Pakistan
Data collection
- 3 Assistant Professor, Radiology Department, Faisalabad Medical University / Allied Hospital, Faisalabad Pakistan
Proof reading & references writing
- 4 Assistant Professor, Radiology Department, Faisalabad Medical University / Allied Hospital, Faisalabad Pakistan
Manuscript writing
- 5 Assistant Professor, Radiology Department, Faisalabad Medical University / Allied Hospital, Faisalabad Pakistan
Compiling the data, References writing

CORRESPONDING AUTHOR

Dr. Amna Rehan

Assistant Professor, Radiology Department,
Faisalabad Medical University / Allied Hospital,
Faisalabad Pakistan
Email: amna.rehan11@yahoo.com

Submitted for Publication: 08-11-2020
Accepted for Publication: 12-05-2021

How to Cite: Rehan A, Hussain Z, Ahmad N, Raouf A, Bukhari H. The Role of Diffusion Weighted Magnetic Resonant Imaging in the Diagnosis of Malignant and Benign Urinary Bladder Lesions. *APMC* 2021;16(1):5-8. DOI: 10.29054/APMC/2021.1083

ABSTRACT

Background: Diffusion Weighted (DW) Magnetic Resonant Imaging (MRI) is a non-invasive modality for predicting histopathological aggressiveness of bladder cancer. It can avert unnecessary biopsies and lend a hand in early planning of management. **Objective:** To determine the diagnostic accuracy of Diffusion Weighted MRI for detection of Malignant Urinary Bladder lesions in patients presenting with hematuria by taking Histopathology as gold standard. **Study Design:** Cross-sectional (validation) study. **Settings:** Radiology department of Allied Hospital, Faisalabad Pakistan. **Duration:** From February 10, 2015 to February 10, 2016. **Methods:** 128 patients of both sexes with age from 20 to 70 years presenting with hematuria and bladder mass on ultrasonograph were included by using non probability consecutive sampling. Patients with history of metallic implants, known pregnant females and claustrophobic patients were excluded. Pelvic examination was performed using 1.5 Tesla ACHIEVA PHILIPS with a sense body-4 coil. The gradient power of superconducting magnet is 30mT/m. FOV 350cm. Cystoscopic biopsy was performed in the Urology Department of Allied Hospital, Faisalabad by consultant urologist and specimen was sent to pathology laboratory of Punjab Medical College, Faisalabad for histopathology. **Results:** In this study, 38(29.69%) were between 20-50 years of age while 90(70.31%) were between 51-70 years of age, average mean of age was 55.62±6.91 years. 97(75.78%) were male and 31(24.22%) were females. Malignant urinary bladder lesions were recorded positive in 91(71.09%). Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy rate of diffusion weighted MRI for detection of malignant urinary bladder lesions in patients presenting with hematuria were recorded as 85.71%, 81.08%, 91.76%, 69.77% and 84.38% respectively. **Conclusion:** DWI may be beneficial in the differentiation of benign and malignant urinary bladder lesions, as well as of high-grade and low-grade urinary bladder carcinomas.

Keywords: Hematuria, Diffusion weighted MRI, Carcinoma, Pelvic examination.

INTRODUCTION

Bladder cancer is one of the most common urinary tract malignancies, causing notable morbidity and mortality.¹ Bladder cancer accounts for almost 4% of all malignancies.² It is the second most common genitourinary malignancy in Westernized countries.³ It accounts for 6% of all male and 2% of all female malignant urothelial tumors, being the most common urological malignancy in Pakistan.⁴ An estimated 386,300 new cases and 150,200 deaths from bladder cancer occurred in 2008 worldwide. The majority of bladder cancer occurs in

males and there is a 14-fold variation in incidence internationally. The highest incidence rates are found in the countries of Europe, North America, and Northern Africa.⁵

A number of emerging imaging techniques have recently been reported in the literature for use in imaging bladder cancer.³ MRI is an accurate technique for the local staging of Bladder Cancer due to its superior spatial and contrast resolution. Anatomical MRI has a modest utility in TNM staging of Bladder cancer. However, incorporation of functional MR techniques, such as diffusion weighted

MRI can improve the results for lesion detection and staging.⁶ Diffusion-weighted MRI (DWI) is a functional imaging technique⁷ that derives image contrast between tissues from differences in the motion of water molecules.⁸ DW imaging is a noninvasive reliable modality for predicting histopathological aggressiveness of bladder cancer.⁹ Apparent diffusion coefficient (ADC) value is a quantitative parameter of diffusion weighted MRI representing water diffusion in extracellular and extravascular space and capillary perfusion.¹⁰

In early studies, the diffusion-weighted images and the apparent diffusion coefficient (ADC) of tissues and lesions were measured, and the different values obtained were shown to be useful in the differential diagnosis. There are studies reporting that benign renal tumors have much higher ADC values than malignant tumors, and that cystic renal lesions have much higher ADC values than benign solid renal tumours.¹¹ Cancerous tissues show high signal intensity on DWI because of their higher cellularity, tissue disorganization, and increased extracellular space tortuosity, which restrict water diffusion. This imaging technique requires no contrast agent and is applicable to patients with allergies against contrast agents or those with existing renal insufficiency.⁸

In a study carried out by Shuichiro Kobayashi and colleagues the sensitivity of Diffusion Weighted MRI was found to be 88% and specificity 85%.¹² In another study carried out by S Avcu and colleagues the prevalence of malignant lesions was found to be 73%.¹¹

The rationale of my study is to see how accurately we can differentiate between malignant and benign urinary bladder lesions by using ADC values on Diffusion Weighted MRI. This study will help both doctors and patients by avoiding unnecessary biopsies and better management.

METHODS

This cross-sectional (validation) study was conducted in Radiology and Urology Department of Allied Hospital Faisalabad from 10-02-2015 to 10-02-2016. Sample size of 128 patients was taken by intriguing sensitivity 88%,⁸ Specificity 85%,⁸ prevalence 73%,⁷ confidence level 95%, precision for both sensitivity and specificity 10%.

Patients of both sexes with age from 20 to 70 years presenting with hematuria and bladder mass on ultrasonograph were included by using non probability consecutive sampling. Patients with history of metallic implants, known pregnant females and claustrophobic patients were excluded.

Permission for research was sought from hospital ethical committee. Patients were collected from OPD & indoor

departments. Objective of study was explained to every subject who fulfilled the inclusion criteria & informed consent was taken. Pelvic examination was performed using 1.5Tesla ACHIEVA PHILIPS with a sense body-4 coil. The gradient power of superconducting magnet is 30mT/m. FOV 350cm.

Before the DWI examination was performed with SS-EPI, a T2 weighted true fast imaging with steady state precession (FISP) sequence with a chemical shift fat suppression technique in the axial and coronal planes (repetition time (TR), 10000 ms; echo time (TE), shortest, 113.66 ms; voxel size, 2.05 mm RL and 2.56 mm AP; NSA, 1; matrix, 256 × 256; slice thickness, 5 mm; FOV, 350 cm; slice gap, 15%) was applied. The protocol used for echoplanar diffusion was defined as 0 mm²s⁻¹/500 mm²s⁻¹/1000 mm²s⁻¹ ADC, or trace diffusion for short. The images were transferred to a work station. Measurements were conducted through a circular region of interest (ROI) on lesions. ADC levels were measured by using the ROI from the most hypointense region of the mass lesions on the bladder wall or the pathological wall thickening, where the ROI areas were recorded in the range of 15–180 mm². The signal intensity changes in the lesions were visually determined according to b=1000 diffusion-weighted trace images and the signal intensities on ADC images. Cystoscopic biopsy was performed in the Urology Department of Allied Hospital, Faisalabad by consultant urologist and specimen was sent to pathology laboratory of Punjab Medical College, Faisalabad for histopathology. In this study, the diagnostic accuracy in patients diagnosed with the DW-MRI technique was compared with the histopathological results of the cystoscopic biopsy. This procedure was performed in Radiology department of Allied hospital and reported under supervision of the supervisor. Data was collected on a predesigned Performa by me.

The data was entered and analyzed by using SPSS V-17. Mean and standard deviation was calculated for all quantitative variables like age. Frequency and percentage were calculated for qualitative variable like gender and true positive. A 2x2 table was constructed to calculate sensitivity, specificity, PPV, NPV and diagnostic accuracy keeping histopathology as gold standard.

RESULTS

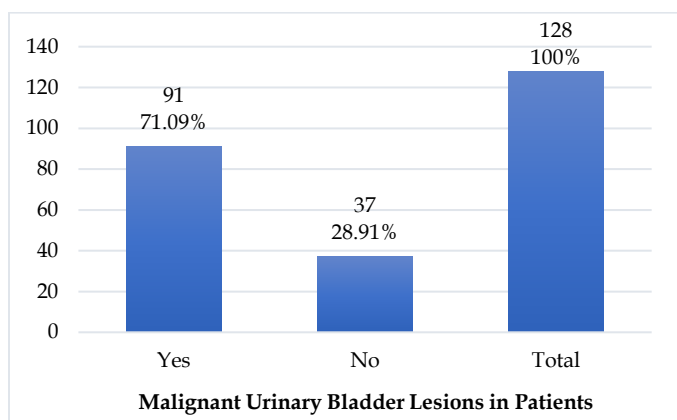
A total of 128 cases presenting with hematuria were enrolled and undergone for Diffusion Weighted MRI for detection of malignant urinary bladder lesions.

Age distribution of the patients was done, majority of the patients 90 (70.31%) were between 51-70 years of age. Gender distribution shows that male patients were dominant i.e., 97 (75.78%). (Table 1)

Table 1: Demographics (n=128)

		No. of patients	Percentage %
Age (in years)	20-50	38	29.69%
	51-70	90	70.31%
Mean ± SD	55.62 ± 6.91		
Gender	Male	97	75.78%
	Female	31	24.22%

Frequency of malignant urinary bladder lesions were recorded positive in 91 (71.09%) while 37 (28.91%) had no findings of the morbidity. (Figure 1)

Figure 1: Frequency of malignant urinary bladder lesions (n=128)

The diagnostic accuracy of diffusion weighted MRI for detection of malignant urinary bladder lesions in patients presenting with hematuria shows that sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy rate was recorded as 85.71%, 81.08%, 91.76%, 69.77% and 84.38% respectively. (Table 2)

Table 2: Diagnostic accuracy of diffusion weighted MRI for detection of malignant urinary bladder lesions in patients presenting with hematuria (n=128)

DW-MRI	Histopathology		Total
	Malignant Urinary Bladder Lesions +ve	Malignant Urinary Bladder Lesions -ve	
Positive	True positive(a) 78	False positive (b) 7	a + b 85
Negative	False negative(c) 13	True negative (d) 30	c + d 43
Total	a + c 91	b + d 37	128

$$\text{Sensitivity} = a / (a + c) \times 100 = 85.71\%$$

$$\text{Specificity} = d / (d + b) \times 100 = 81.08\%$$

$$\text{Positive predictive value} = a / (a + b) \times 100 = 91.76\%$$

$$\text{Negative predictive value} = d / (d + c) \times 100 = 69.77\%$$

$$\text{Accuracy rate} = a + d / (a + d + b + c) \times 100 = 84.38\%$$

DISCUSSION

In recent years, a number of different MRI methods together with conventional ones have been used as part of a routine radio diagnostic application. Diffusion-weighted MRI (DWI) is considered to be such an imaging method, evaluated within the context of functional MRI and based on the measurement of the accelerated or decelerated microscopic diffusion movements in the protons of the tissues' water molecules. Images can be obtained in short-period snapshots and do not require any contrast.

A previous study carried out by Shuichiro Kobayashi and colleagues the sensitivity of Diffusion Weighted MRI was found to be 88% and specificity 85%.¹³ In another study carried out by S AVCU and colleagues the prevalence of malignant lesions was found to be 73%.¹¹ The findings of our study are in agreement with the above studies.

In a study carried out by Abou-El-Ghar *et al*,¹² 130 (106 with bladder carcinoma) patients with gross hematuria underwent T2 weighted MRI, DWI and, after 48 h, cystoscopy. The sensitivity of DWI in detecting the tumor mass by itself was found to be 98.5% and the positive predictive value was 100%.

Al Johi *et al*¹⁴ found 94.5% sensitivity and 87.5% specificity of DWI for detection of bladder cancer. Barsoum *et al*¹⁵ found DWI 100% sensitive, 75% specific and diagnostic accuracy of 98% for detection of urinary bladder carcinoma. Abdel Hameed *et al*¹⁶ found DW-MRI 100% sensitive, specific and accurate for detection of bladder cancer.

Another study by El-Assmy *et al*,⁴ DWI and T2 weighted MRI were compared for accuracy of tumor staging in a total of 106 patients with 106 bladder tumors. DWI alone was found to be more accurate than T2 weighted MRI for tumor staging. In another study carried out by El-Assmy *et al*¹⁷ on 43 patients with bladder tumors, the ADC was found to be significantly lower in bladder carcinomas than in the surrounding tissues.

Takeuchi *et al*¹⁸ investigated a total of 52 bladder tumors in 40 patients and found that DWI contributed to T staging, and that ADC levels in the tumors of higher grade were found to be significantly lower than those in tumors of lower grade.

Before histopathological sampling, more accurate predictions can be made about the malignant potential of urinary bladder lesions. Because it is non-invasive, fast and does not require contrast material administration or ionizing radiation, DWI is a beneficial and safe method for the differentiation of malignant and benign urinary bladder lesions and for providing information about the grade of urinary bladder carcinomas.

CONCLUSION

We concluded that DWI may be beneficial in the differentiation of benign and malignant urinary bladder lesions, as well as of high-grade and low-grade UB carcinomas.

LIMITATIONS

The sample size is small in this study. Further studies should be conducted with larger sample size.

SUGGESTIONS / RECOMMENDATIONS

DW MRI should be used in normal routine for assessment of malignancy of urinary bladder lesions for early and prompt treatment plan.

CONFLICT OF INTEREST / DISCLOSURE

The study has been submitted as dissertation at College of Physicians and Surgeons, Pakistan as a prerequisite for FCPS radiology degree.

ACKNOWLEDGEMENTS

Special thanks of gratitude to Histopathology Department, Faisalabad Medical University, Faisalabad for their co-operation.

REFERENCES

- Li H, Liu L, Shi Q, Stemmer A, Zeng H, Li Y, et al. Bladder cancer: detection and image quality compared among iShim, RESOLVE, and ss-EPI diffusion-weighted MR imaging with high b value at 3.0 T MRI. *Medicine (Baltimore)*. 2017;96(50):e9292.
- Ghafoori M, Shakiba M, Ghiasi A, Asvadi N, Hosseini K, Alavi M. Value of MRI in local staging of bladder cancer. *Urol J*. 2013;10(2):866-72.
- Wang H, Guo Y, Zhou X, Yang D. Urinary bladder cancer: the current and potential role of MR imaging in non-distant metastatic lesions. *J Cancer Ther*. 2013;4(1):504-12.
- El-Assmy A, Abou-El-Ghar ME, Mosbah A, et al. Bladder tumour staging: comparison of diffusion- and T2-weighted MR imaging. *Eur Radiol*. 2009;19(7):1575-81.
- Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. *CA Cancer J Clin*. 2011;61:69-90.
- Bouchelouche K, Turkbey B, Choyke PL. PET/CT and MRI in bladder cancer. *J Cancer Sci Ther*. 2012;14(1):7692.
- Yoshida S, Koga F, Kobayashi S, Tanaka H, Satoh S, Fujii Y, et al. Diffusion-weighted magnetic resonance imaging in management of bladder cancer, particularly with multimodal bladder-sparing strategy. *World J Radiol*. 2014;6(6):344-54.
- Yoshida Y, Masuda H, Ishii C, Tenaka H, Fujii Y, Kawakami S, et al. Usefulness of diffusion-weighted MRI in diagnosis of upper urinary tract cancer. *AJR Am J Roentgenol*. 2011;196(1):110-16.
- Abdelsalam EM, El Adalany MA, Fouda MEA. Value of diffusion weighted magnetic resonance imaging in grading of urinary bladder carcinoma. *Egypt J Radiol Nucl Med*. 2018;49(2):509-18.
- Esen M, Onur MR, Akpolat N, Orhan I, Kocakoc E. Utility of ADC measurement on diffusion-weighted MRI in differentiation of prostate cancer, normal prostate and prostatitis. *Quant Imaging Med Surg*. 2013;3(4):210-16.
- Avcu S, Koseoglu MN, Ceylan K, Dbulutand M, Unal O. The value of diffusion-weighted MRI in the diagnosis of malignant and benign urinary bladder lesions. *Br J Radiol*. 2011;84(1006):875-82.
- Abou-El-Ghar ME, El-Assmy A, Refaie HF, El-Diasty T. Bladder cancer: diagnosis with diffusion-weighted MR imaging in patients with gross hematuria. *Radiology* 2009;251(2):415-21.
- Kobayashi S, Koga F, Yoshida S, Masuda H, Ishii C, Tanaka H, et al. Diagnostic performance of diffusion-weighted magnetic resonance imaging in bladder cancer: potential utility of apparent diffusion coefficient values as a biomarker to predict clinical aggressiveness. *Eur Radiol*. 2011;21(10):2178-86.
- Al Johi RS, Seifeldein GS, Moeen AM, Aboulhagag NA, Moussa EM, Hameed DA, et al. Diffusion weighted magnetic resonance imaging in bladder cancer, is it time to replace biopsy? *Cent European J Urol*. 2018;71(1):31-7.
- Barsoum N, Talaat M, Saraya S. Can diffusion-weighted MRI predict the histological grade of urinary bladder carcinoma? *Kasr Al Ainy Med J*. 2017;23:86-95.
- Abdel Hameed HA, Ali Nagi MAM, Wali DH. Role of diffusion weighted magnetic resonance imaging (DW-MRI) in assessment of urinary bladder carcinoma. *Egypt J Hosp Med*. 2018;72(11):5561-70.
- El-Assmy A, Abou-El-Ghar ME, Refaie HF, El-Diasty T. Diffusion-weighted MR imaging in diagnosis of superficial and invasive urinary bladder carcinoma: a preliminary prospective study. *Sci World J*. 2008;8(2):364-70
- Takeuchi M, Sasaki S, Ito M, Okada S, Takahashi S, Kawai T, et al. Urinary bladder cancer: diffusion-weighted MR imaging – accuracy for diagnosing T stage and estimating histologic grade. *Radiology*. 2009;251(2):112-21.