

Role of Multi Parametric MRI and its Correlation with Histopathology Assumed as Gold Standard for Local Staging of Urinary Bladder Cancer

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Abstract: Background: A cross sectional prospective study done to compare sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of different sequences of multi-parametric MRI with histopathological findings assumed as gold standard. Material and methods: sixty patients suspected with bladder cancer either clinically, through urine cytology or using other radiologic investigations including Ultrasonography by using hitachi aloka F 37 and Arietta 50 USG Machine or computed tomography were prospectively included and multi-parametric MRI data was interpreted by using philips ingenia 3 Tesla MRI Machine. Multi-parametric MRI techniques included role of high resolution T2 weighted images (HR T2WI), diffusion weighted MRI (DW-MRI) and dynamic contrast enhanced MRI (DCE-MRI). Accuracy of these techniques was measured separately and in conjunction using histopathological findings as reference gold standard. Results and discussion: Histopathological confirmation for local T staging was performed in 50 patients (83%) from cystoscopy and biopsy or from transurethral resection of bladder tumors (TURBT) and from radical cystectomy in 10 patients (16.6%). T2W-MRI correctly diagnosed local T stage of UB cancer in 30/60 patients (50%) while diagnosed 45/60 patients (75%) with DCE-MRI and 48/60 patients (80%) with DW-MRI. MP-MRI correctly diagnosed the local T stage in 51/60 patients (85%). Overall diagnostic accuracy increased from 50% in T2W to 75% in DCE-MRI to 80% in the DW-MRI and to 85% in the multi-parametric MRI. Conclusion: Multi-parametric MRI is a broad and more effective tool for the local T staging of urinary bladder cancers.

Keywords: Urinary Bladder Cancer, Multiparametric MRI, Histopathology

1. Introduction

Urinary bladder cancer (UBC) is one of the top 10 most common types of cancer worldwide with approximately 5,50,000 new cases per year.^[1] Global incidence of bladder neoplasms account for 3.2% of all tumors, with 1.1% in men and 0.27% in women worldwide.^[2] More than 90% BC are of urothelial type and 6-8 % are squamous cell carcinomas and 2% are adenocarcinomas.^[3] BC is classified as non-muscle invasive (NMIBC) which is 70% and muscle invasive (MIBC) form 30% of total BC cases.^[4] NMIBCs are usually low grade but have high recurrence and 30% of these can progress to muscle invasive form. MIBCs are aggressive and along with those NMIBCs that progress to MIBC are the main cause of mortality in bladder cancer.

Approximately 2.1% of all cancer deaths are due to urinary bladder cancer (UBC). The global ASR for mortality in males is 3.2 and in females is 0.9 per 100,000 per year.^[1] Treatment of bladder cancer is thus warranted which is aimed at reducing rate of recurrence, progression and at improving and maintaining quality of life. Success of treatment depends upon accurate histological staging and tumor grading of the disease.

There is a risk of error in staging of the urinary bladder cancer with single test which is reduced by the multimodality approach but this may lead to a dilemma while staging when results conflict because each modality

is operator dependant which influences inter-rater reliability. In this study, we evaluated the role of mp-MRI in urinary bladder cancer staging compared with histopathological staging as gold standard.

2. Aim and Objective

To identify the role of multi-parametric MRI and its correlation with histopathology assumed as gold standard for local staging of urinary bladder cancer with following objective –

To compare sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of different sequences of multi-parametric MRI with histopathological findings assumed as gold standard.

3. Material and Methods

A cross sectional prospective study was planned in the department of radiodiagnosis and department of urology, SMS hospital, Jaipur, Rajasthan after taking ethical clearance from institutional ethical committee. All sixty patients with clinically suspected urinary bladder cancer referred to department of radiodiagnosis for imaging, were analyzed from July, 2019 to July, 2020 and included in the study based on inclusion and exclusion criteria. The entire pelvis was imaged from aortic bifurcation to inferior margin of pubic symphysis and multi-parametric MRI data was interpreted by using 3T MRI Machine (philips ingenia

3.0T, equipment no. 42192). Multi Parametric MRI techniques included role of high resolution T2 weighted images (HR T2WI), diffusion weighted MRI (DW-MRI) and dynamic contrast enhanced MRI (DCE-MRI). Accuracy of these techniques was measured separately and in conjunction using histopathological findings as reference gold standard.

Inclusion Criteria

- 1) Patients suspected to have urinary bladder cancer on basis of history, clinical examination and ultrasound.
- 2) Those who are willing to give written and informed consent to be included in study.

Exclusion Criteria

- 1) Patients unfit for MRI studies due to orthopedic implants, aneurysmal clips, cardiac pacemaker, implanted cardiac defibrillator, cochlear, otologic or other ear implants, surgical staples, clips or metallic suture, metallic stent, heart valve prosthesis.
- 2) Patients of urinary bladder cancer with other malignancy.
- 3) Patients with bleeding diathesis.
- 4) Patients who refuse surgery.

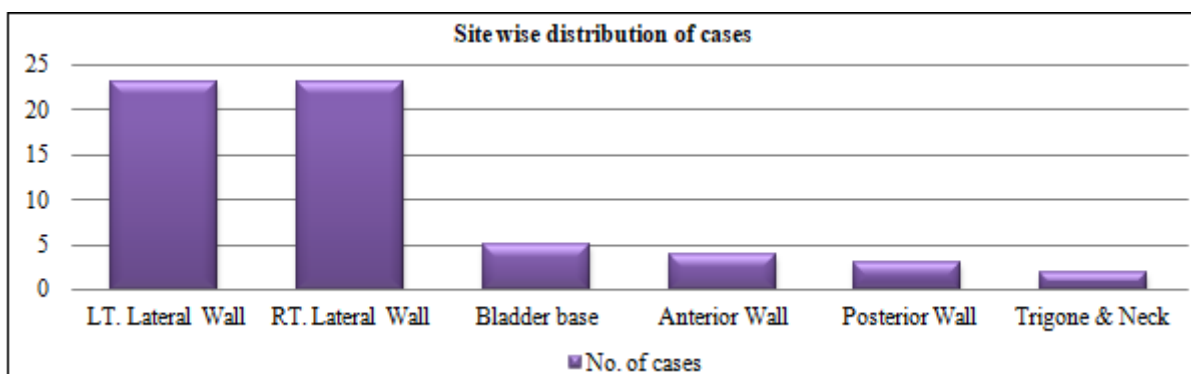
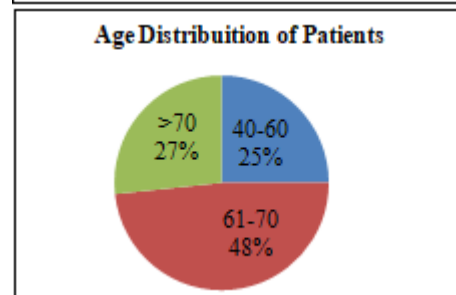
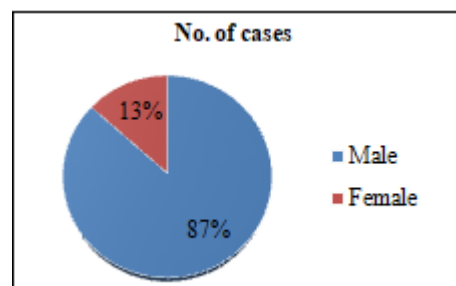
4. Results

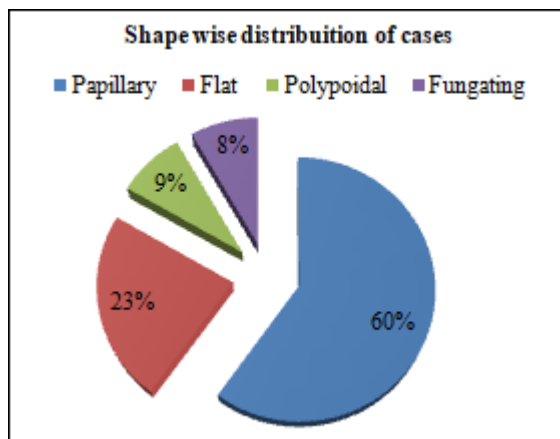
A total of 60 patients were included in our study with mean age of 64.37 years. 48% of the total patients were in the age range of 61-70 years, followed by 27% in > 70 years and 25% in 40-60 years .87% cases were male and 13% cases were female.

In present study mean age of male was 64.94±9.77 years and female was 64.88±8.13 years.76 % Tumor cases was found at right and left lateral wall and 3 % cases was found at trigone and neck. In present study 60% cases were papillary type, 23% cases were flat, 8% cases were polypoidal and 8% cases were fungating in shape.

T2W-MRI correctly diagnosed local T stage of UB cancer in 30/60 patients (50%) while diagnosed 45/60 patients (75%) with DCE-MRI and 48/60 patients (80%) with DW-MRI. MPMRI correctly diagnosed the local T stage in 51/60 patients (85%).

Diagnostic accuracy of mp-MRI in differentiating non muscle invasive from muscle invasive disease ($\leq T1$ versus $\geq PT2$ stage) was 95% with sensitivity (100%), specificity (92.11%), positive predictive value (88%) and negative predictive value (100%). The diagnostic performance accuracy of mp-MRI for differentiating organ-confined versus non-organ-confined disease ($\leq T2$ versus $\geq T3$ stage) was 90% with sensitivity (88%), specificity (100%), positive predictive value (100%) and negative predictive value (50%).





Distribution of cases according to MRI Step by Step Staging results (n = 60)

MRI Step by Step Staging	Correct		Overstaging		understaging	
	No.	%	No.	%	No.	%
T2W-MRI	30	50.0	30	50.0	0	0.0
DW-MRI	48	80.0	12	20.0	0	0.0
DCE-MRI	45	75.0	15	25.0	0	0.0
Multi Parametric-MRI (T2WI&DWI&DCE)	51	85.0	9	15.0	0	0.0

Diagnostic performance efficacy in the local T staging of Multi Parametric-MRI (T2WI + DWI +DCE-MRI), its results in the differentiation of ≤T1 versus ≥stage T2 carcinomas & its results in the differentiation of ≤T2 versus ≥stage T3 carcinomas

Multi-parametric MRI	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
T1	92.11	100	100	88.00	95.00
T2	62.50	93.18	76.92	87.23	85.00
T3	100	91.07	44.44	100	91.67
T4	100	98.28	66.67	100	98.33
≤T1 versus ≥ T2	100	92.11	88.00	100	95.00
≤T2 versus ≥T3	88.89	100	100	50.00	90.00

5. Discussion

Urinary bladder carcinomas are a heterogenous disease with multiple possible treatment modalities and a wide spectrum of clinical outcome. Treatment plan and prognostic expectations hinge on the accurate and precise staging, and the recently published American Joint Committee on cancer (AJCC) Staging Manual, 8th edition, should be the basis for staging of urinary bladder tumor as tumors of stage T1 or less treated with local therapy while stage T2 or greater are treated by partial or total cystectomy or by adjuvant therapies. Improving MRI technology had led to introduction of mp-MRI (including high resolution T2 WI, DW MRI and DCE MRI) combining both anatomic and functional sequences to improve the local staging and

providing adequate information on tumors demography, extra-vesical spread and nearby organ invasion proving a feasible and reasonably accurate technique for the local staging of bladder cancer to optimize the treatment.^[6] Additionally, MR imaging has the advantage of involving non ionizing radiation.

Staging accuracy of high resolution T2 W-MRI in current study was (50%), the extent of agreement with pathological data was fair (k = 0.278) and over staging detected in 50% of patients. This was less than Takeuchi et al. ^[7] who showed diagnostic accuracy of 67% and better than Abou El-Ghar ME et al. ^[6] with diagnostic accuracy of 39.6%.

In current study, overall staging accuracy of DCE-MRI was (75%), the extent of agreement with pathological data was fair (0.276) & over staging was detected in 25% of patients. Similarly, Gupta et al. ^[6] detected staging accuracy of DCE MRI 73.3%, the extent of agreement with the pathological data was substantial (k = 0.619) and overstaging in 20%.

In current study, overall staging accuracy of DW-MRI was (80%), the extent of agreement with pathological data was moderate (k = 0.582) & overstaging was detected in 20% of patients. This is in agreement with Gupta et al. ^[6] who detected DWI staging accuracy as 76.7%, the extent of agreement with pathological data was substantial (k = 0.669) and overstaging in 16.7%.

Overall staging accuracy of mp-MRI in current study was 85%, extent of agreement with pathological data was substantial (k = 0.733), overstaging detected only in 15% of patients, confirming higher diagnostic accuracy and better agreement with pathologic findings.

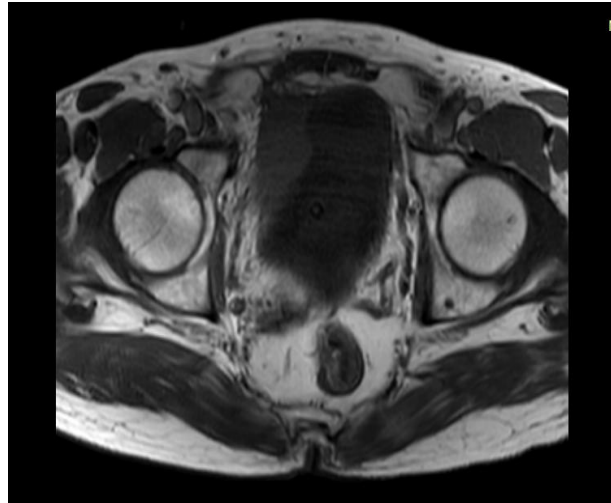
6. Conclusion

For the radiological evaluation of UBC, mp-MRI is valuable imaging modality due to high tissue contrast resolution, no radiation exposure, multiplanner imaging capabilities, and the possibility of tissue characterization. It is extensively effective tool for determining the local T stages of urinary bladder cancers.

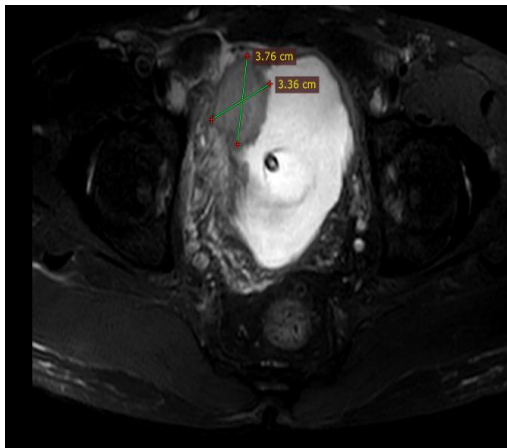
7. Limitations of Study

- 1) It was a single hospital based study with a small sample size so it's difficult to generalize the results; a multicentric study with a larger sample size is desirable.
- 2) Multiparametric MRI is costly and not easily available.

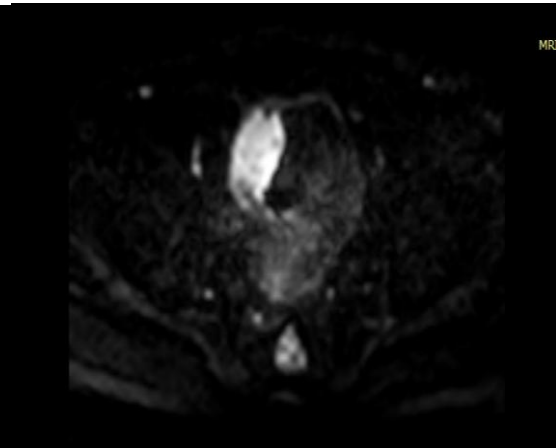
Case: A 58-year-old male patient with history of recurrent hematuria.



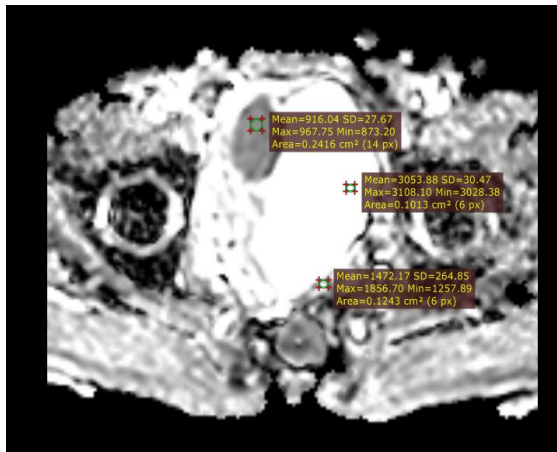
(A)



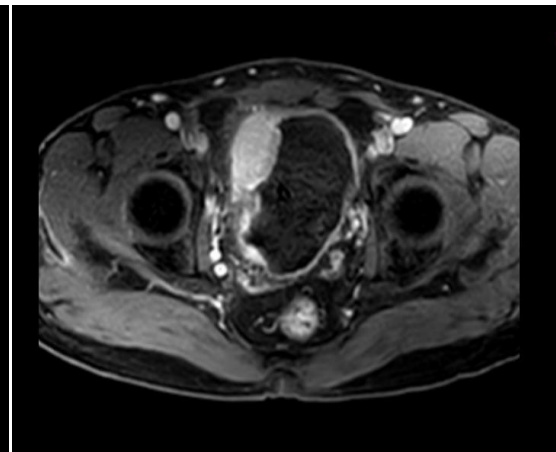
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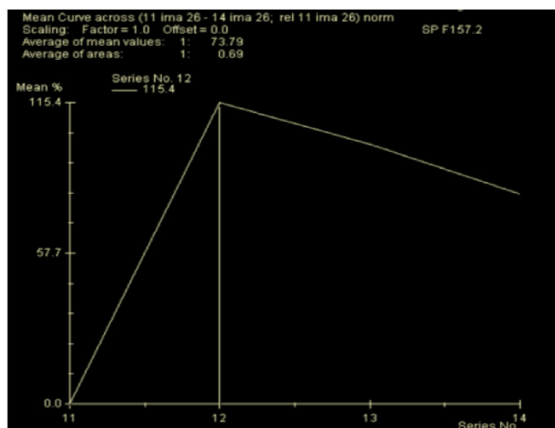
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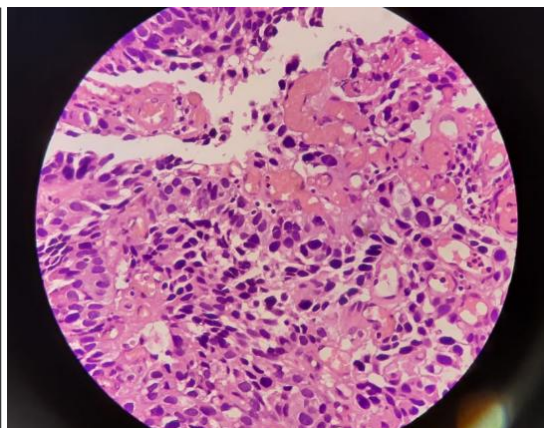
(D)



(E)



(F)



(G)

- (A) T1 WI showed fungating infiltrating UB mass, seen at the right lateral wall showed intermediate signal intensity.
 (B) T2WI showed involvement of the underlying muscle layer by the mass lesion and perivesical extension.
 (C) DW-MRI showed marked restriction of the mass lesion with involvement of the underlying muscle layer.
 (D) ADC values of the UB mass 0.916 - The normal bladder wall 1.472 & Urine 3.053×10^{-3} mm²/s; ADC mapping consistent with high grade neoplastic process.
 (E) DCE-MRI showed marked enhancement of the mass with focal involvement of the underlying muscle layer.
 (F) Time-intensity curve showed grade 3 curve with early enhancement and wash out pattern. Multi Parametric MRI features of High grade stage T3 muscle invasive urinary bladder carcinoma.
 (G) It was as confirmed high grade TCC PT3 on histopathology.

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