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Diagnostic Accuracy of Magnetic Resonance Imaging in diagnosing Urinary Bladder Cancer, Taking Histopathology as Gold Standard

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ABSTRACT

Objective: To determine the diagnostic accuracy of Magnetic resonance imaging in diagnosing and staging urinary bladder cancer, taking histopathology as gold standard.
Study Design: Descriptive, Cross-sectional study.
Place and Duration of Study: The study was done in Department of Diagnostic Radiology, Combined Military Hospital, Multan, Pakistan from Jan to Dec 2020.
Methodology: A total of 117 patients with irregular soft tissue structures of low echogenicity projecting into the bladder lumen from a fixed mural site on ultrasonography aged 20-60 years of either gender were included in the study. While patients already taking radiotherapy or immunotherapy or having any other contraindication to Magnetic resonance imaging were excluded. Magnetic resonance imaging was performed in every patient using 1.5 Tesla MR system. Magnetic Resonance Imaging findings were interpreted by consultant radiologist for presence or absence of urinary bladder carcinoma and further local staging of carcinoma if present. Magnetic resonance imaging findings were compared with histopathology results taken via cystoscopy.
Results: All the patients were subjected to Magnetic resonance imaging abdomen pelvis and found that 60 were True Positive and 05 were False Positive. Among 52, MRI negative patients, 05 (False Negative) had urinary bladder carcinoma on histopathology whereas 47 (True Negative) had no carcinoma on histopathology (p=0.0001). Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of Magnetic resonance imaging in diagnosing and staging urinary bladder cancer, taking histopathology as gold standard was 92.31%, 90.38%, 92.31%, 90.38% and 91.45% respectively.
Conclusion: MRI is a highly sensitive and accurate noninvasive modality for diagnosing urinary bladder cancer.
Keywords: Urinary bladder cancer, Magnetic resonance imaging, Sensitivity.

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INTRODUCTION

Recently bladder cancer is now diagnosed to be one of the most common cancers worldwide with incidence reaching upto nearly 550,000 new cases with resultant mortality of about 200,000 patients per year.[1] Within the last three decades transitional cell carcinoma (TCC) has emerged to be the most common type.[2] In recent era diagnostic imaging assessments have become important for early diagnosis of bladder cancer as well as they help in staging the disease which help in devising management protocols,[3] which eventually dictates the prognosis of disease. Cystoscopy with biopsy is still the gold standard tool for diagnosing and staging bladder cancer due to its high sensitivity in detecting early lesions and the ease of simultaneous tumor resection in same procedure, however it is limited in accurately diagnosing the extent of extra vesical tumor invasion and in detection of early flat lesions when sufficient mucosal abnormality is not yet produced.[4] Currently a third of all cases are initially diagnosed as muscle –invasive bladder cancer.[5] and radical cystectomy is then the only treatment of choice. However, as the concerns for patients' quality of life has increased in recent years, there is growing trend of bladder-sparing approaches with various treatment modalities.[6] However for this approach meticulous evaluation of the bladder cancer is mandatory. MRI plays a pivotal role in the early diagnosis and local staging of bladder cancer because of its superiority in soft tissue delineation especially in the context of muscle-invasion and T staging.[7] MRI can be efficiently used in our health care system for this purpose, however currently not much data is

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available in literature regarding this aspect, especially in South East Asia. Therefore, this study was planned to get local statistics which are applicable to our population, especially in locality of southern Punjab. The objective of the study is to determine the diagnostic accuracy of magnetic resonance imaging (MRI) in diagnosing and local staging urinary bladder cancer, taking histopathology as gold standard. It would help to determine a non- invasive method to diagnose bladder cancer and also help the urologist to take pre-operative managements protocols accordingly and guide them about the site of biopsy which contains the highest maximum tumor bulk during cystoscopy.

METHODOLOGY

This cross sectional descriptive study was conducted in the Diagnostic Radiology department, Combined Military Hospital, Multan from January 2020 to December 2022. Approval from the ethical review committee of the hospital (IREB approval letter no.13/TRG/2022) was taken as per protocol. Sample size of 117 was calculated using WHO sample size calculator with specificity of MRI in staging urinary bladder cancer as 85.0% and 94.0% respectively.[8] The Patients were recruited through non-probability, consecutive sampling was done.

Inclusion Criteria: 20-60 years old patients of either gender. Patient referred for biopsy and MRI had either symptoms of hematuria or had sonographic report of presence of irregular soft tissue structures of low echogenicity projecting into the bladder lumen from a fixed mural site were included.

Exclusion Criteria: Patients already taking radiotherapy or immunotherapy for any disease, claustrophobic patients or those having any contraindication to MRI i.e. MRI incompatible prosthesis or cardiac pacemaker holders were excluded.

A total of 117 consecutive patients presented to radiology department of CMH Multan, fulfilling the inclusion criteria, were enrolled for the study. Patient's data was recorded on pre designed performas. After informed written consent magnetic resonance imaging of every patient was performed on 1.5 Tesla MR Toshiba Unit. MR examination was performed with the patients in supine position with a body phased-array coil. All sequences were obtained using a non-breath hold technique. After scout scanning, axial and sagittal T1W and T2W turbo spin-echo (T2W-TSE) images were obtained. Then in all patients, diffusion weighted imaging (DWI) MR sequences with b=0, b=500 and b=1000, followed by apparent diffusion coefficient (ADC) mapping was done. Post-processing reformats were obtained. T2WS and DWI findings were interpreted for presence or absence of tumor and muscle invasion. MRI findings of T1 isointense lesion compared to muscles and T2 hyperintensity confined upto or invading the muscles with or without breech in serosal lining along with high signal on DWI and low value on ADC were taken as positive. Later the patients were sent for cystoscopy & biopsy. Histopathology report was prepared by consultant histopathologists especially trained in genitourinary oncology. Presence of cellular atypia on slides, increased mitotic figures or >1:1 nuclear cytoplasmic ratio up to bladder muscles on histopathology were taken as positive.

MRI and histopathology findings were recorded and analyzed through computer software Statistical Package for Social Sciences (SPSS) version 20.0. Age and sex of patients, duration of disease and size of the tumor were presented as mean and standard deviation. Urinary bladder cancer on MRI, its local staging and histopathology results (present/absent) were presented as frequency and percentage. 2×2 contingency table was used to calculate sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of MRI.

RESULT

Mean age of patients included in study was 44.81±9.15 years with age range of 20-60 years Out of these 117, 66(76.41%) patients were males and 51(43.59%) were femaleswith ratio of 1.3:1. Mean duration of disease was 7.03±1.88 months. Mean size of tumor was 3.50±1.97 cm. All the patients were subjected to MRI and found that 60 were True Positive and 05 were False Positive. Among 52, MRI negative patients, 05 (False Negative) had urinary bladder carcinoma on histopathology whereas 47 (True negative) had no carcinoma on histopathology (p=0.001) as shown in Table-I. Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of magnetic resonance imaging (MRI) in diagnosing and staging urinary bladder cancer, taking histopathology as gold standard was 92.31%, 90.38%, 92.31%, 90.38% and 91.45% respectively.

In our study, the mean tumor size was found to be 3.50 cm, while 67% of the patients had tumor size >3cm on presentation. Most common site involved

was left posterolateral wall of urinary bladder (67%), followed by base of bladder (20%), while trigone was involved in 1%cases only . Muscle invasion was found in 70% of the cases corresponding to stage T2b, while T4 stage seen as invasion of pelvic viscera or side walls while only 2% of the patients were diagnosed as having T1 STAGE , appearing as preservence of T2 hypointense band of detrusor muscle Figure.

Table-I: Diagnostic Accuracy of Magnetic Resonance Imaging (MRI) Indiagnosing and Staging Urinary Bladder Cancer, Taking Histopathology as Goldstandard.

	Positive result on Histopathology	Negative result on Histopathology	*p*-value
Positive result on MRI	60 (TP)*	05 (FP)***	0.0001
Negative result on MRI	05 (FN)**	47 (TN)****	0.0001

-TP=True positive **-FP=False positive *-FN=False negative ****-TN=Truenegative*

Table–II: Diagnostic accuracy of MRI

Sensitivity	**92.31%**
Specificity	90.38%
Positive Predictive Value (PPV)	92.31%
Negative Predictive Value (NPV)	90.38%
Diagnostic Accuracy	91.45%

Figure: (a,b) Coronal and axial T2Fat Sat Image Showing Figure-1 Hyperintense Lesion Involving the Left Lateral wall of Urinary bladder extending beyond the serosa, involving left VUJ and left Anterolateral Aspect of Cervix Along with a left Pelvic nodal Deposit , c,d) axial DWI Sequences Showing Restricted Diffusion in the Tumor and Adjacent left Pelvic Nodal Deposit . Stage-T4N2Mx

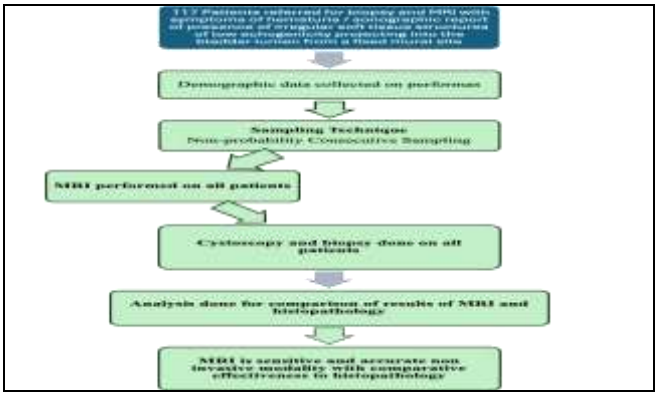

Figure-2 : Patient Flow Diagram

DISCUSSION

Different imaging modalities, i.e. ultrasonography, fluoroscopy, contrast-enhanced CT are being used for the radiological evaluation of genitourinary tumors. Each imaging modality has different diagnostic accuracy and limitations, owing to this various methods have been explored time by time in order to improve the accuracy of staging bladder cancer especially at the earliest T stage (T1 or T2). Screening ultrasound is used as a basic tool for evaluation of complaints of hematuria. Contrast-enhanced CT is generally reserved to screen for metastatic disease after diagnosis of cancer, while MRI has now emerged as a basic imaging modality for locally staging bladder cancer. This is largely because of its greater ability of soft tissue contrast resolution that makes it more optimal tool than CT for detecting detrusor muscle, perivesical tissues or regional visceral invasion.[9] The addition of newer sequences in MRI especially Diffusion weighted imaging (DWI) has been shown to further improve local staging, diagnostic accuracy anddetection of malignant regional lymph nodes.[10] In one of the study, El Assmy et all compared the staging accuracy of diffusion-weighted imaging (DWI) to T2-weighted sequences and found DWI superior in staging organ-confined tumors i.e. ≤T2 disease.[11] Likewise, Takeuchi *et al.* found that adding DWI information to already acquired T2-weighted images significantly improves the accuracy, specificity and sensitivity of T staging.[12] Abou El-Ghar *et al*. compared T2W MRI and DW MRI in the detection of bladder carcinoma in 130 patients and reported sensitivity and specificity values of 96% and 86% for T2W MRI, respectively.[13]

Initially only histopathology was used for T staging of tumors. Now with the advent of advance imaging modalities, CT/MRI can confidently delineate

T stage of the tumors with diagnostic accuracy comparable to histopathology. The T stage of the urinary bladder tumors is classified into four categories [T1 or lower, T2 (T2a or T2b), T3 (T3a or T3b), and T4 (T4a or T4b)] in accordance with the 2017 8th TNM classification of malignant tumors.[14] On T2W images, a T2 hypo-intense band of the normal detrusor muscle outlines the bladder lumen. Stage Ta, Tis, or T1 bladder cancer shows an intact T2 hypointense band. The T2 hypo-intense band and the irregular inner margin at the junction of bladder tumor and normal tissue suggest T2a stage, while in the T2b stage, the T2 hypo-intense band is disrupted, without invasion of the

adjacent peri-vesical fat. When the tumor signal extends into the fat, it is considered as T3 stage, while when it extends into the adjacent organs or the pelvic wall, T4 stage is considered.

I have conducted this study to determine the diagnostic accuracy of magneticresonance imaging (MRI) in diagnosing and staging urinary bladder cancer, takinghistopathology as gold standard in a tertiary care hospital in southern Punjab, Pakistan. My study concluded that overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of magnetic resonance imaging (MRI) in diagnosing and staging urinary bladder cancer, taking histopathology as gold standard was 92.31%, 90.38%, 92.31%, 90.38% and 91.45% respectively. Narumi et al reported an overall diagnostic accuracy of MRI of 92%,[15] which is comparable to our study.

A prospective study conducted by Daneshmand *et al*.[16] on 122 patients using gadolinium enhanced MRI concluded 88% sensitivity, 48% specificity, and 74% accuracy in differentiating organ-confined from non–organ-confined bladder cancer.[17] Another publication by Gupta N *et al*. report the sensitivity and specificity for differentiating organ-confined from non–organ confined tumors at 90 to 94% and 60% to 94%.[18] However the addition of dynamic contrast enhanced imaging with DWI and T2-weighted imaging is found to be the most optimal MRI technique for the local staging of bladder cancer.[19] Noting that MRI has better sensitivity and specificity than CT for local staging, Klein and Pollack,[20] found that both MRI and CT have similar accuracy for detecting perivesical fatinvasion, while in terms of differentiation between superficial and deep invasion of the bladder wall MRI is superior. A review by Beyersdorff *et al*.[21] contends "MRI is superior [to CT] for evaluation of the depth of invasion in the bladder wall." This study also concluded that "both modalities continue to have difficulties in determining whether perivesical changes are related to tumor or inflammation from the previous transurethral biopsy." However, recent studies regarding the addition of DWI to standard pelvic MRI found to be superior in differentiating treatment response and residual/recurrent disease. MRI has been reported to be more precise in the identification and localization of lymph nodes in the setting of pelvic malignancy when compared to CT scan.

LIMITATION OF STUDY

Due to limited resources, contrast enhanced studies were not done in our patients. Further more inter-observer variation in interpretation of MRI & histopathology slides can effect the results of the studies .

RECOMMENDATION

Contrast enhanced MRI was not done in patients included in our study, as post contrast T1WS can further increase the diagnostic accuracy of MRI in tumor detection and its local staging . So future studies can be directed to see effects of contrast enhanced MRI on sensitivity & specificity.

CONCLUSION

This study concluded that MRI is a highly sensitive and accurate noninvasivemodality for diagnosing urinary bladder cancer, and has improved patient care byearly screening, timely and proper treatment and avoiding unnecessary diagnosticbiopsies, which consequently reduces patients' morbidity and mortality. So, werecommend that MRI should be used routinely as a prime modality for theassessment of pre-operative urinary bladder lesions for selecting proper treatmentoption and post-operative management plan.

Conflict Of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

MA & SA: Data acquisition, data analysis, critical review, approval of the final version to be published.

AT & YK: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AL & MA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity

of any part of the work are appropriately investigated and resolved.

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