"Comparison of Accuracy Between CT Versus MRI in Staging of Muscle Invasive Bladder Carcinoma"

Mohammed Noori Al-Musawi*. Anas Mohammed Al-obaidi

ABSTRACT:

BACKGROUND:

Transitional cell carcinoma of the bladder is one of the most widely recognized cancers affecting the genitourinary tract and it is the second most common cancer in Iraqi male population .Cross sectional imaging studies assume a significant role in the staging of this cancer , also the prognosis of the patients with bladder carcinoma worsens with higher stage and accurate preoperative radiological staging is required to increase cancer free survival for patients submitted for radical cystectomy.

OBJECTIVE:

To compare the accuracy of computed tomography and magnetic resonance imaging for staging of muscle-invasive bladder cancer.

PATIENTS AND METHODS:

Twenty patients were included in the study hnd undergone staging for their muscle invasive bladder cancer by the use of computed tomography scan and magnetic resonance imaging at least two weeks of their last trans-urethral resection of tumour, the radiological staging was compared to the staging of the histopathological reports of the radical cystectomy of the included patients.

RESULTS:

The staging accuracy of the computed tomography was 93.8%, sensitivity 88.8%, specificity 90.2%, while magnetic resonance imaging accuracy of staging was 71.30%, sensitivity 45.8%, specificity 81.70%. Accuracy increased with advancing stage.

CONCLUSION:

It is concluded that computed tomography staging is more accurate than magnetic resonance imaging tumor staging in patients with muscle invasive bladder cancer, with comparable results in lymph node staging.

KEY WORDS: computed tomography,magnetic resonant imaging,muscle invasive bladder cancer

INTRODUCTION:

Although clinical staging is exact in assessing non-invasive tumors, it is inclined to both under staging and over staging of invasive lesions[1]. Subsequently, imaging strategies, for example, CT and MRI may assume a significant role in accurate disease staging[1] Concerning Cross-Sectional Imaging (CT and MRI), the tumor in the bladder might be distinguished either as a thickening of the bladder wall or as an intraluminal mass. On CT, intraluminal tumors may infrequently show fine calcifications. On MRI, the tumors show up somewhat hyperintense in respect to muscle on T2-weighted sequences and isointense with respect to muscle on T1-weighted sequences [2] . CT has sensitivities of 79–89.7% and specificities extending from 91% to 94.7% in detecting bladder carcinoma[3,4]. Assessing small bladder primary tumors on CT and MRI can be troublesome in light of the fact that under distention of the bladder causes the presence of bladder wall thickening, which can be mistakenly considered as a tumor, and because over distension can flatten a few tumors. Asymmetric wall thickening is regularly useful in confining the tumor[4] . Current CT and MRI techniques can't resolve the different bladder wall layers precisely, along these lines truly restricting the accuracy of staging, especially in recognizing among T1, T2, and T3 tumors[2] .On MRI, T2a and T2b tumors can sometimes be separated utilizing a combination of T2-weighted and contrast enhanced T1-weighted sequences; on

Iraqi Council for Medical Specialization.

T2-weighted sequences, the hypo intense band (muscle) is preserved in T2a tumors [2] . CT and MRI can be useful in recognizing invasive tumors confined to the bladder from those that have spread to the extravesical fat (T3) and to the adjacent organs and the abdominal and pelvic walls (T4) [5] Microscopic fat invasion can't be identified. Macroscopic extravesical extension (T3b) is seen on CT and MRI as a irregular, ill-defined outer bladder wall and by the presence of soft-tissue nodules or fat stranding in the surrounding perivesical fat [5] . Lymphatic spread occurs with invasive tumors and typically occurs contiguously by moving first into the anterior and lateral perivesical lymph nodes and then to the sacral and presacral nodes, followed by the hypogastric, obturator , and external iliac nodes [6] .The frequency of nodal metastasis is around 30% for tumors involving the bladder wall and roughly 60% for those with extravesical invasion[6]. Albeit size is the most commonly utilized criterion to assess nodal involvement, it is not a reliable indicator of the presence of disease, since small lymph nodes can contain tumor and enlarged nodes might be reactive yet may not contain tumor. Occasionally, the shape of the lymph nodes can be useful: Round nodes are more likely to be metastatic than are ovoid nodes [7] . Standard CT and MRI have comparable rates of precision for pelvic nodal staging: 70–97% and 73–98%, respectively [8] . However, some authors have reported that dynamic contrast enhancement characteristics of lymph nodes utilizing contrast-enhanced MRI may improve the accuracy of MRI because most metastatic lymph nodes take up the contrast agent more quickly than do hyperplastic or nonmetastatic lymph nodes [8] . Regarding Distant Metastases(M Stage): TCC of the bladder may also spread hematogenously. The incidence of distant metastasis increases with increasing T and N stages [9] .The most widely recognized sites of metastases are the liver, bones, and lungs in decreasing order of frequency [9] ,most of them can be checked by one run CT but not by MRI in one protochol.

PATIENTS AND METHODS:

Our institutional ethics committee were reviewed and approved the study protocol. Informed consent was obtained from all patients. Twenty patients with MIBC were included in the study ,those who merit our inclusion criteria were examined by CT and MRI scan. The tumors were staged using the final histopathology (after cystectomy) according to TNM classification of the International Union Against Cancer and counted as the gold standard for the study. Exclusion criteria was patients with distant metastasis or had a contraindication to MRI study (e.g. presence of pacemaker or metallic prostheses) and Patients who are unfit or refuse surgery. Patients arrive for their examination with a full bladder. In patients with a urethral catheter, 150–300 ml sterile saline was used to distend the bladder. Patients were imaged on 64 slice-detector row CT scanners. Images were acquired by using CT parameters of 120kV; section thickness 5 mm ; tube current 175 mA ;and 1 pitch. Checking was with and without contrast. Contrast Ultravist 370(Iopromide) enhancement at arterial phase was used. Also those patients underwent MRI on a 1.5-T scanner MRI. Conventional T1-weighted spin-echo, T2-weighted spin-echo, and unenhanced and enhanced (0.1 mmol/kg gadolinium), Magnevist (dimeglumine godopentetate) contrast was used. Fast spoiled gradient-echo images with fat suppression were obtained. The following parameters were used: slice thickness of 5 mm, intersection gap of 1 mm and field of view (FOV) =300 (mm). To nullify interobserver and intraobserver variability both studies were reviewed by two radiologists and reported the results after making consensus.Cross-tabulation was performed to assess the agreement of each of CT and MRI from one side against histopathology from the other side, Percent agreement was calculated by dividing the number of cases that both tests agreed in detection of T by the total number of cases (20). Additionally, as the percent agreement alone is not enough to judge a test, measure of reliability (kappa) test used and the kappa coefficient (κ) was calculated. Kappa coefficient (κ) is a statistic that is used to measure inter-rater reliability (and also Intra-rater reliability) for qualitative (categorical) items [10] .The interpretation of kappa results as followed.

kappa coefficient (κ) value	Interpretation
≤ 0	No agreement
0.01–0.20	Slight
0.21–0.40	Fair
0.41– 0.60	Moderate
0.61–0.80	Substantial
0.81–1.00	Almost perfect agreement

Bivariate analysis, Pearson's and Spearman's tests, used to assess the correlation between validity parameters and agreements of CT and MRI (vs. histopathology) in T staging with each of age and gender of the cases, Level of significance in all statistical analyses and procedures was set at ≤ 0.05. Finally, the results presented in tables and figures with an explanatory paragraph for each using Microsoft Office Word and Excel Software version 2013.

RESULTS:

A total of 20 patients were enrolled in this prospective study with a mean age 62 ± 11.4 (range 50 – 85 years, where 16 cases were males (80%) compared to only 4 females (20%). The staging of malignant tumors according to different diagnostic modalities is shown in (Table 1). The CT-scanning revealed none of the cases with T1, but, T2 in 4 cases (20%), T3 in 12 (60%) and T4 in 4 cases (20%). MRI reported one case (5%) with T1 , 9 cases (45%) with T2, 7 cases (35%) T3 and 3 cases (15%) as T4. Histopathology revealed that one case with T1, 5 (25%) T2, 8 (40%) T3 and 6 cases (30%) as T4.Regarding the N staging, CT reported only 2 cases as N1 and 18 as N0, MRI reported only one case as N1 and 19 N0. By histopathology, 12 cases (60%) were N0, 3 cases (15%) N1 and 5 cases (25%) were N2.

Table 1:Staging of malignant tumor according to different diagnostic modalities.

Staging		CT		MRI		Histopathology	
		No.	%	No.	%	No.	%
T	T1	0	0.0	1	5.0	1	5.0
	T2	4	20.0	9	45.0	5	25.0
	T3	12	60.0	7	35.0	8	40.0
	T4	4	20.0	3	15.0	6	30.0
Total		20	100.0	20	100.0	20	100.0
N	N0	18	90.0	19	95.0	12	60.0
	N1	2	10.0	1	5.0	3	15.0
	N2	0	0.0	0	0.0	5	25.0
Total		20	100.0	20	100.0	20	100.0

The cross-tabulation between CT from one side against histopathology from the other side regarding T staging is demonstrated in (Table 2). This analysis revealed that CT agreed the histopathology staging in 15 cases (3 as T2, 8 T3 and 4 cases T4), giving a percent agreement of (75%) which is good agreement, additionally, the measure of reliability , Kappa coefficient was (0.615, P. value = 0.001) indicated that CT had Substantial reliability in T-staging compared to histopathology, (Table 2) .Furthermore, the ability of CT to identify T-staging was assessed through the calculation of validity parameters (Sensitivity, Specificity, accuracy, PPV and NPV) for CT against histopathology (as gold standard) for each T stage and the overall T-staging , this analysis showed that CT was more sensitive in advanced stages , in T4 (sensitivity, 100%), in T3 (sensitivity, 80%) and lower sensitivity reported for T2, (75%) while not much difference in specificities across the T stages. However, in T staging , CT had an overall validity parameters as follows; Sensitivity 88.8%, Specificity 90.2%, Accuracy 93.8% , PPV 76.7% and NPV of 94.8% , indicated that CT was good sensitive, specific and high accuracy with small false negative rate and accepted false positive rate.

Table 2: Cross-tabulation of CT against histopathology (agreement and reliability of CT in T staging).

CT- T staging	Histopathology (T)				Total
	T1	T2	T3	T4	
T1	0	0	0	0	0
T2	1	3	0	0	4
T3	0	2	8	2	12
T4	0	0	0	4	4
Total	1	5	8	6	20
kappa coefficient (κ)*= 0.615, P. value= 0.001, significant Percent agreement = 75%, (good agreement)					

Regarding the agreement between MRI and histopathology, cross-tabulation of MRI against histopathology (Table 3), showed that MRI agreed histopathology staging in 10 cases (3 cases as T 2, 4 as T3 and 3 cases as T4) giving a percent agreement of 50% and the kappa coefficient was 0.286 indicated a fair reliability and agreement.Assessment of validity parameters for each T and overall T-staging revealed that MRI had lower rates than CT, but the same trend as the CT did, i.e. the sensitivity increased in advanced stage, (0% for T1, 33.3% for T2, 50% for T3 and 100% for T4), additionally, MRI had higher rates than CT in identifying the T4 .However, the overall rates indicated that MRI was low sensitive, (sensitivity; 45.8%), good specific (81.7%) and good accurate (71.3%) with moderate PPV (60.4%) and good NPV (81.2%) .

Table 3:Cross-tabulation of MRI against histopathology (agreement and reliability of MRI in T staging).

MRI- T staging	Histopathology (T)				Total
	T1	T2	T3	T4	
T1	0	0	1	0	1
T2	1	3	3	2	9
T3	0	2	4	1	7
T4	0	0	0	3	3
Total	1	5	8	6	20
kappa coefficient (κ)*= 0.286, P. value= 0.038, significant Percent agreement = 50%, (Fair agreement)					
*Kappa coefficient (κ) is a statistic that is used to measure inter-rater reliability (and also Intra-rater reliability) for qualitative (categorical) items (10)					

Further analysis was performed to assess the agreement between CT and MRI in T staging, (Table 4), where MRI agreed CT in 11 cases giving a percent agreement of 55% and fair agreement (kappa coefficient (κ)= 0.328). From other point of view, the comparison of validity parameters of CT and MRI is shown in (Table 5 and figure 1), where CT had higher sensitivity, specificity , accuracy, PPV and NPV than MRI.

Table 4: Cross-tabulation of MRI against CT (agreement between MRI and CT in T staging).

MRI- T staging	CT- T staging			Total
	T2	T3	T4	
T1	0	1	0	1
T2	3	6	0	9
T3	1	5	1	7
T4	0	0	3	3
Total	4	12	4	20
kappa coefficient (κ) = 0.328, P. value= 0.017, significant Percent agreement = 55%, (Fair agreement)				

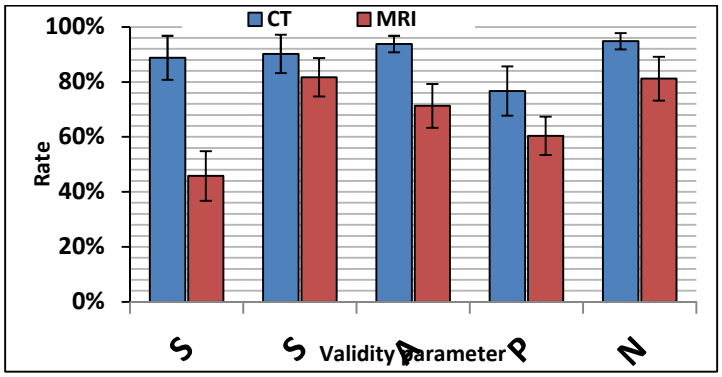

Figure 1: Bar-Chart graphical presentation for the comparison of the validity parameters of CT and MRI in T-staging.

In regard to the ability of CT to detect L.N compared to histopathology: Computed Tomography detected (18 N0 , 2 N1) compared to Histopathology detection of (12 N0 , 3 N1 , 5 N2) , the agreement was fair reaching 65% with kappa coefficient of 0.216 as shown in (Table 5).The validity parameters were as follows: sensitivity(92.3%), specificity (12.5%) ,accurate in (65%) , PPV (63.2%) , NPV (50.0%).

Table 5: Cross-tabulation of CT against histopathology (agreement and reliability of CT in N staging).

CT (N) * Histopathology (N) Cross tabulation					
		Histopathology (N)			
		N0	N1	N2	Total
CT (N)	N0	12	2	4	18
	N1	0	1	1	2
Total		12	3	5	20
kappa coefficient (κ) = 0.216, P. value= 0.028, significant Percent agreement = 65%, (Fair agreement)					

While the ability of MRI to detect L.N compared to histopathology Where as follows MRI discovered (19 N0 , 1 N1) compared to histopathology detection of (12 N0 , 3 N1 , 5 N2) , the agreement was slight reaching 65% with kappa coefficient of 0.172 as shown in (Table 6).The validity parameters were as follows: sensitivity(100%), specificity (12.5%) ,accurate in (65%) , PPV (63.2%) , NPV (100%).

(agreement and reliability of MRI in N staging)

MRI (N) * Histopathology (N) Cross-tabulation					
		Histopathology (N)			
		N0	N1	N2	Total
MRI (N)	N0	12	2	5	19
	N1	0	1	0	1
Total		12	3	5	20
kappa coefficient (κ) = 0.172, P. value= 0.044, significant Percent agreement = 65%, (Slight agreement)					

DISCUSSION:

The CT-staging accuracy in our study was higher than other studies in the literature. It is found that the overall CT staging accuracy was 93.8%, sensitivity 88.8%, specificity 90.2 %, while in a comprehensive literature review which was performed by Bostrom PJ et al, they found an overall accuracy of 35–55% , sensitivity 93–95% , specificity 28–71% [11] .Paik ML et al found the overall accuracy of CT was 54.9% [12], Koss et al found the overall accuracy of CT staging was 64% [13] , Amendola MA et al found CT accuracy was 40% [14] .This obvious discrepancy could be explained in part by the late presentation of the disease in Iraqi patients and small sample size taken in this study .

MRI validity parameters in overall staging of bladder tumour in the present study are as follows: accuracy 71.3% , sensitivity 45.8% , specificity 81.7% ,which agreed a comprehensive literature review which was performed by Bostrom PJ et al who found an overall accuracy of 62–85%, sensitivity 80–100%, specificity 78–91% [11] .According to the above mentioned results of the present study , CT was superior to MRI to accurately stage MIBC in terms of accuracy , sensitivity and specificity which was different from literature review which was performed by Bostrom et al [11] . The present study CT accuracy in detecting L.N metastasis was 65.0% which was comparable to the results of Stefan et al which was 58% [15] , but lower than the results of a comprehensive literature review which was performed by Bostrom PJ et al [11] ,who found an overall accuracy of detecting nodal disease 70–97%. Computed tomography accuracy of 70%, 90%,by Drieskens O et al , Paik ML et al respectively [12,10] .The present study MRI accuracy in detecting L.N metastasis was 65.0% which was comparable to the results of studies by Drieskens O et al , who found an accuracy of 64% [16] , but lower than the results of Bostrom PJ et al metanalysis, who found an overall accuracy of nodal disease 73–98% [11].

Also staging of bladder cancer is really where CT has excelled. In one session of an examination, the chest, retroperitoneum, abdominal and pelvic cavity as well as the groin regions are easily imaged while this is not the case with MRI exam. Magnetic resonance imaging examination requires more time than CT ,MRI study is more expensive than CT study that puts a burden on the medical institution , also the availability of CT device is more than MRI device .Additionally, according to the present study ,the detection rate of MRI and CT was not affected by age or gender of the patients, in all comparisons.

Microscopic perivesical spread (stage T3a disease) cannot be identified at either CT or MR imaging[5] ,and it was a limitation in the presents study also.Macroscopic perivesical disease (stage T3b) can be confidently diagnosed at CT , only in the presence of moderate tumor volume outside the bladder. Perivesical fat stranding may often be seen following the treatment of bladder cancer due to surrounding edema or inflammation and does not necessarily signify stage T3b disease [17,18] .An important limitation of both techniques is the inability to distinguish tumor spread from fat

stranding or nodularity resulting from cystoscopy and biopsy. Hence, imaging for local staging is best undertaken before biopsy or resection, but this is not always feasible.

CONCLUSION :

It is concluded that CT tumor staging is more accurate than MRI staging in patients with MIBC, with comparable results in lymph nodes staging.

REFERENCES:

1. Husband JES, Reznek RH. Imaging in oncology, 2nd ed. London, UK: Taylor & Francis, 2004:343–74.
2. Ng CS. Radiologic diagnosis and staging of renal and bladder cancer. InSeminars in roentgenology 2006 ; 41: 121-38). WB Saunders Ltd.
3. Knox MK, Cowan NC, Rivers-Bowerman MD, Turney BW. Evaluation of multidetector computed tomography urography and ultrasonography for diagnosing bladder cancer. Clinical radiology. 2008;63:1317-25.
4. Sadow CA, Silverman SG, O'Leary MP, Signorovitch JE. Bladder cancer detection with CT urography in an Academic Medical Center. Radiology. 2008;249:195-202.
5. Husband JE. Staging bladder cancer. Clinical radiology. 1992;46:153-59.
6. MacVicar AD. Bladder cancer staging. BJU international. 2000;86:111-22.
7. Jager GJ, Barentsz JO, Oosterhof GO, Witjes JA, Ruijs SJ. Pelvic adenopathy in prostatic and urinary bladder carcinoma: MR imaging with a three-dimensional TI-weighted magnetization-prepared-rapid gradient-echo sequence. AJR. American journal of roentgenology.1996; 167:1503-7.
8. Husband JE. Computer tomography and magnetic resonance imaging in the evaluation of bladder cancer. J Belge Radiol 1995;78:350–55.
9. Knap MM, Lundbeck F, Overgaard J. Prognostic factors, pattern of recurrence and survival in a Danish bladder cancer cohort treated with radical cystectomy. Acta Oncologica. 2003;42:160-68.
10. McHugh ML. Interrater reliability: the kappa statistic. Biochemia medica: Biochemia medica. 2012;22:276-82.
11. Bostrom PJ, Van Rhijn BW, Fleshner N, Finelli A, Jewett M, Thoms J, Hanna S, Kuk C, Zlotta AR. Staging and staging errors in bladder cancer. European Urology Supplements. 2010;9:2-9.
12. PAIK ML, SCOLIERI MJ, Brown SL, SPIRNAK JP, RESNICK MI. Limitations of computerized tomography in staging invasive bladder cancer before radical cystectomy. The Journal of urology. 2000;163:1693-96.
13. JC Koss JC, Arger PH, Coleman BG, Mulhern Jr C, Pollack HM, Wein AJ. CT staging of bladder carcinoma. American Journal of Roentgenology. 1981;137:359-62.
14. Amendola MA, Glazer GM, Grossman HB, Aisen AM, Francis IR. Staging of bladder carcinoma: MRI-CT-surgical correlation. American Journal of Roentgenology. 1986;146:1179-83.
15. Tritschler S, Mosler C, Straub J, Buchner A, Karl A, Graser A, Stief C, Tilki D. Staging of muscle-invasive bladder cancer: can computerized tomography help us to decide on local treatment?. World journal of urology. 2012;30:827-31.
16. Drieskens O, Oyen R, Van Poppel H, Vankan Y, Flamen P, Mortelmans L. FDG-PET for preoperative staging of bladder cancer. European journal of nuclear medicine and molecular imaging. 2005 ;32:1412-17.
17. Tekes A, Kamel I, Imam K, Szarf G, Schoenberg M, Nasir K, Thompson R, Bluemke D. Dynamic MRI of bladder cancer: evaluation of staging accuracy. American Journal of Roentgenology. 2005 ;184:121-27.
18. Hayashi N, Tochigi H, Shiraishi T, Takeda K, Kawamura J. A new staging criterion for bladder carcinoma using gadolinium-enhanced magnetic resonance imaging with an endorectal surface coil: a comparison with ultrasonography. BJU international. 2000;85:32-36.