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The Role of Transabdominal Ultrasonography, Computed Tomography and Magnetic Resonance Imaging in Pre-Operative Staging and Post-Therapeutic Assessment of Bladder Carcinoma

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Abstract

The most important information for treatment of cancer bladder is to know its exact staging. A total of 73 bladder cancer patients was evaluated by both transabdominal ultrasonography and computed tomography. MRI was performed in only 10 patients. The findings on different imaging techniques were compared with the histological staging. A proper diagnosis was made in 57 of 73 cases (78%) by transabdominal ultrasound, in 61 of 73 cases (83.5%) by CT and in 8 of 10 (80%) by MRI when compared with histological findings. Our data showed very promising results of MRI in regional staging of bladder cancer and in our opinion, it is more accurate than ultrasonography and may be more useful than CT.

Introduction

BLADDER cancer is the most common type of cancer amongest Egyptian population. Because of the geographic coincidence of bladder cancer and endemic bilharziasis, a casual relationship has been established. Carcinoma of the urinary bladder comprises up to 32% of all cancer reporting to the national cancer institute, Cairo University [1, 2].

The 5 years survival rates are not high even when the tumour is confined to the

mucosa (63%) and is worsened by muscular invasion (21%) [3].

The most important factors affecting the survival of patients with bladder cancer are the histologic grading and tumour staging at time of diagnosis.

Diagnostic accuracy in clinical staging of bladder cancer, using the traditional methods is still imperfect, as clinical and pathological staging do not always corelate. The accuracy of the new imaging techniques in the staging as well as the follow-up of this kind of neoplasia, has yet to be assured [4].

This work aims at evaluation of the role of the current diagnostic imaging modalities including and staging of bladder cancer as well as their role in post-treatment evaluation.

Material and Methods

Our study included 73 patients (61 males and 12 females) presenting with signs and symptoms suggestive of urinary bladder neoplasm. Most of the patients were reffered to the national cancer institute, Cairo University. Their ages ranged from 35-72 years.

All patients were subjected to the following:

- Full clinical evaluation including bimanual examination under general anaesthesia to assess clinical staging.

- Transabdominal ultrasound examination of the abdomen and pelvis using Picker real time equipment with 3.5 and 5 MHZ transducers.

- Computed tomography of the pelvis using different scanners (Philips tomoscan 350, Somatom DRH and GE, 9800). Patients were routinely scanned in supine position. The examination covered the area between the iliac crests and the symphysis pubis with 5mm-thickness cuts.

Intravenous injection of urographic contrast material (telebrix 38% or urographin 76%) was done routinely after conventional scanning, followed by performance of additional serial scans.

- MR imaging was performed in 10 patients with a superconducting magnet system (Signa-general electric) operating at 1.5 tesla. Data were obtained with a 59cm. Body radiofrequency (RF) coil and a 256x256 matrix. Multisection spin echo (SE) T1 weighted sequences were obtained using repitition time (TR)ranging from 500-700 Msec. and echotime (TE) of 20-30 Msec. (SE) double echo sequences and multisection technique (Tr=2000, TE = 25/90) with one acquisition were also performed. The section thickness in all scanning planes (Axial, Sagittal and Coronal) was set at 5mm.

All patients were examined with T1 weighted pulse sequence in the axial and sagittal orientations before and after intravenous administration of 0.1 mmol of GD-DTPA (magnevist, Schering, Berlin) per kgm. of body weight.

Histopathological diagnosis and staging of urinary bladder carcinoma was achieved in every patient by transurethral endoscopic biopsy. Staging was further documented in 56 patients who undergone total or partial cystectomy.

Follow-up post-treatment examinations (following surgery and/or chemo or radiotherapy) were performed in 19 patients by transabdominal ultrasonography (all patients), CT scan (10 patients) and MRI (5 patients) to assess the contribution of each diagnostic modality.

Results

73 patients with histopathologically proven carcinoma of the urinary bladder were evaluated clinically and by different imaging modalities aiming at preoperative accurate diagnosis and staging.

Our results are analyzed and tabulated in tables from 1 to 9 (as follows).

Table 1: Clinical Presentation in our Cases.

Clinical Presentation	No. of cases	%
Pain	14	19.2
Dysuria	23	31.5
Haematuria	21	28.8
Necroturia	11	15.1
Retension of Urine	4	5.4
Total	73	100.0

Table 2: Bilharzial Detection in 73 Patients.

Bilharzial Detection	No. of cases	%
+ ve History	16	21.9
+ ve Urine Analysis	30	41.1
+ ve Radiology	23	31.5.
+ ve Pathology	42	57.5
Non-Bilharzial	12	16.4
Total	73	100.0

Table 3: Tumour Histology in 73 Patients.

Tumour Histology	No. of cases	%
Squamous cell carcinoma	44	60.2
Transitional cell carcinoma	19	16.2
Adenocarcinoma	7	9.6
Undifferentiated carcinoma	3	4.1

Table 4: The Staging System Followed in our Study in that of the Union Internationsl Center le Cancer (UICC).

Stage	Pathologic Findings
Tis	Carcinoma in situ
Ta	Papillary non-invasive tumour
T1	Tumour involving the lamina propria
T2	Tumour involving the superficial muscle layer
T3a	Tumour involving the deep muscle layer
T3b	Involvement of the perivesical fact
T4	Extension into the pelvic viscera
N1	Contralateral or bilateral nodes
N3	Fixed regional nodes
M	Distant metastases

Table 5: Accuracy of Transabdominal Ultrasonograply in Staging Bladder Cancer in 63 Patients.

Pathologic Staging	No. of Patients	Transabdominal Ultrasonography		
		Correct staging	Over staging	Under staging
T2	1	1	0	0
T3a	8	6	2	0
T3b	21	16	5	0
T4	33	28	0	5
Total	63	51	7	5

Table 6: Accuracy of Computed Tomography in Staging Bladder Cancer in 63 Patients.

Pathologic Staging	No. of Patients	Transabdominal Ultrasonography		
		Correct staging	Over staging	Under staging
T2	1	0	1	0
T3a	8	5	3	0
T3b	21	19	2	0
T4	33	30	0	3
Total	63	54	6	3

Table 7: Accuracy of MRI in Staging Bladder Cancer in 10 Patients.

Pathologic Staging	No. of Patients	Magnetic Resonance Imaging (MRI)		
		Correct staging	Over staging	Under staging
T2	2	1	1	0
T3a	5	4	1	0
T3b	1	1	0	0
T4	2	1	0	1
Total	10	7	2	1

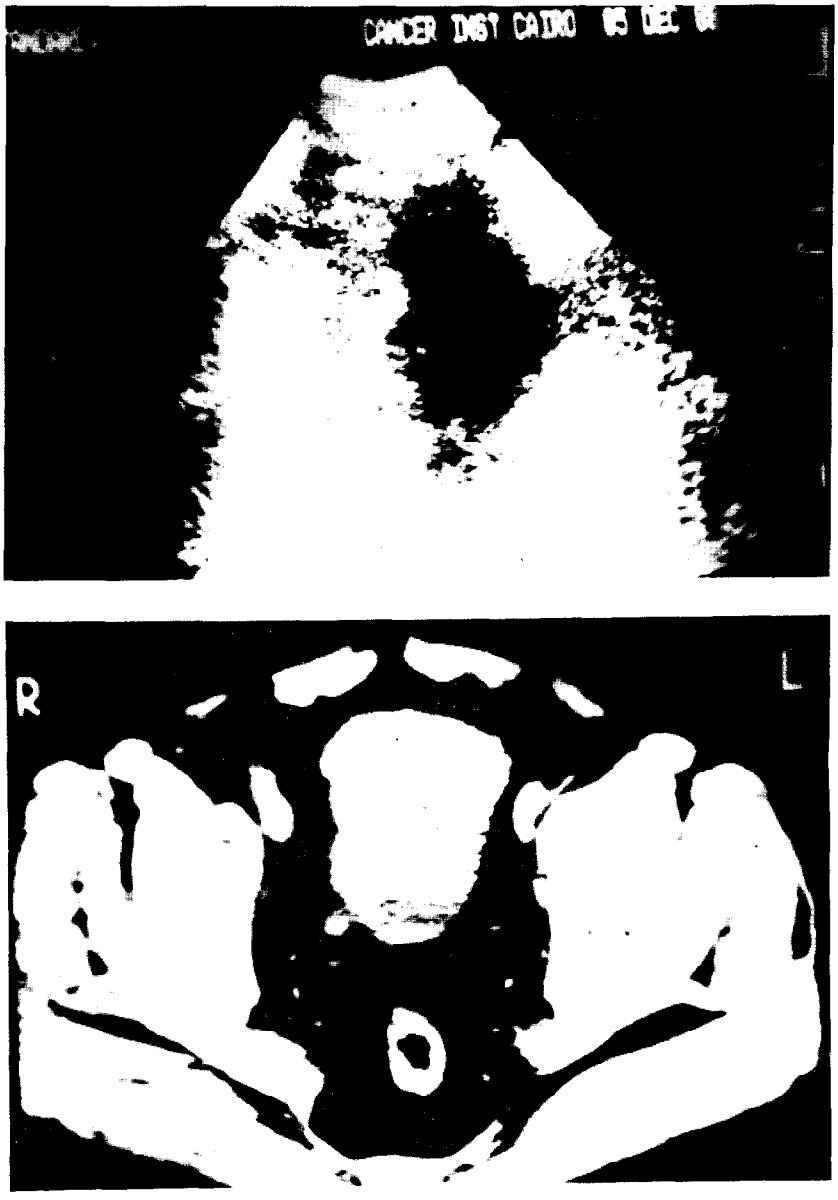

Fig. 1: Squanous cell carcinoma (T3a)

(A) Transverse U.S. scan: The echogenic tumour mass is seen along the right lateral and posterior walls of the bladder with preserved deep muscle layer.

(B) Post contrast axial CT scans showing the intravesical tumour mass with no evidence of extravesical extension or infiltration of the perivesical planes.

Fig. 2: Squanous cell carcinoma (T3b)

(A) Transverse U.S. scan showing an intravesical mass of heterogenous echogenicity with dilated ureter.

(B) Pre contrast CT scan showing the tumour mass contrasted by the hypodense urine. Interruption of the mural calcification is seen along the left side. The left ureter is markedly dilated.

Fig. 3: Squanous cell carcinoma (T4)

(A) Transverse U.S. scan: showing a small left lateral intravesical mass with extravesical extension.

(B) Pre contrast CT scan showing the intravesical mass with extravesical extension reaching the lateral pelvic wall. Intravesical air-fluid level suggested the presence of malignant fistulous communication with the gut (Proved surgically).

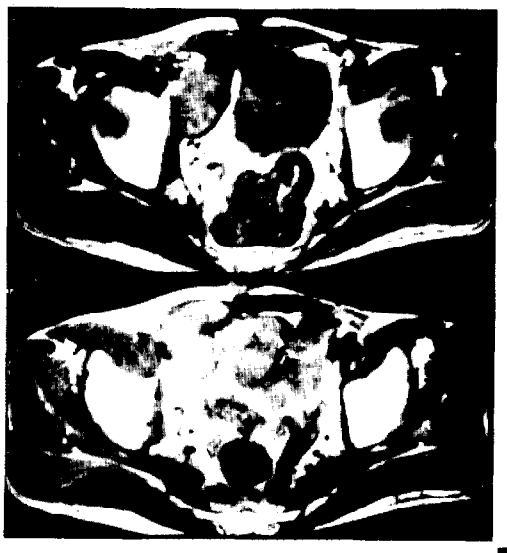

Fig. 4: Squanous cell carcinoma (T3a)

MRI axial T1 weighted images demonstrating the intravesical tumour tissue in the right antrolateral aspect of the bladder with enlargement of the ipsilaterl internal iliac lymph nodes.

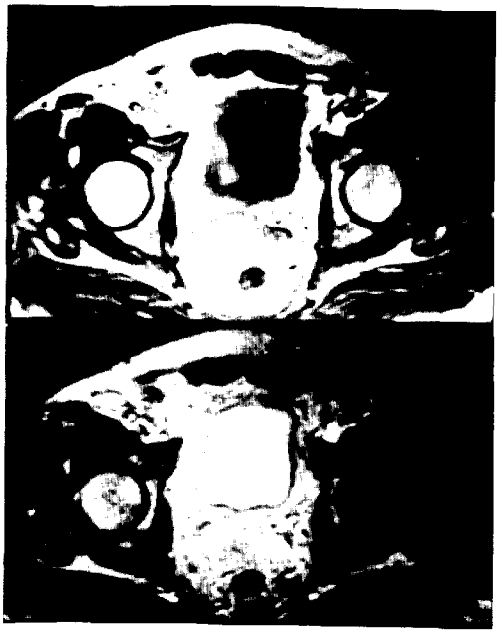

Fig. 5: Transitional cell carcinoma (T3b)

(A) MRI coronal T1 weighted images showing non uniform thickening of the urinary bladder wall with fine reticulations of the urinary bladder wall with fine reticulations of the perivesical hyperintense fat, sugesting its invasion.

(B) MRI axial proton density (above) and T2 weighted images (below) showing the vesical lesion with relative hyperintensity along the right lateral bladder wall in proton density images. In T2 WIs-the hyperintense lesion could not be clearly defined against-the hyperintense urine in the bladder.

Table 8: Staging Accuracy of US, CT and MRI in 10 Patients.

Pathologic Staging	Patients	Us Staging			CT staging			CT staging		
		Correct	Over	Under	Correct	Over	Under	Correct	Over	Under
T2	2	2	0	0	1	1	0	1	1	0
T3a	5	3	2	0	3	2	0	5	0	0
T3b	1	0	0	1	1	0	0	1	0	0
T4	2	1	0	1	2	0	0	1	0	1
Total	10	6	2	2	7	3	0	8	1	1

Table 9: Post-Therapeutic Findings in 9 Patients.

Therapy / Imaging	Surgery		Chemo-and /or radiotherapy			Total
	Recurrence	No. Rec.	No Response	Parital Response	Complete Response	
Us	3	2	6	4	4	19
CT	3	1	1	1	4	10
MRI	3	1	-	1	-	5

Discussion

Carcinoma of the urinary bladder is one of the major oncologic problems in Egypt. Early detection and accurate clinical as well as pathological staging of bladder cancer are essential for adequate management of these patients [5].

The current availability of different, almost noninvasive imaging modalities such as ultrasonography, computed tomography and more recently magnetic resonance imaging, has provided a considerably more accurate preoperative diagnosis and staging of bladder cancer compared to the previous unsatisfactory results obtained by bimanual examination radiographic technique [6].

Although excretory urography remains the most common initial radiological examination for evaluation of the urinary

system, its accuracy in diagnosis and staging of bladder carcinoma is, however, limited. The major argument in favour of retaining the intravenous urogram as the initial screening examination in cases of suspected cancer bladder is the exclusion of multifocal transitional cell neoplasm in the upper urinary tract as well as the detection of non-neoplastic conditions in combination with bladder cancer [7].

During the last several years, ultrasonography and computed tomography have provided the most exact methods for imaging and staging urinary bladder tumours [8]. More recently MR imaging has shown very promising results in preoperative evaluation of bladder cancer. The efficacy of transabdominal ultrasonography, computed tomography and MR imaging in detection and staging of bladder tumours was the major aim of this work comparing our imaging findings with pathological results provided by surgery or biopsy.

Transabdominal ultrasonographic examination was performed for all our patients. The detection of bladder tumours by ultrasound in our cases was largely affected by the size and location of the lesion. The tumour size in most of our cases was above 1 cm in diameter being related to the usual late presentation. Some difficulties were encountered in detecting anterior wall bladder tumours as well as those arising in the bladder dome. Similar findings have been reported [10].

The results of transabdominal ultrasound are shown in tables 5,8. The overall accurate diagnostic rate was 78% with 12.4% being overstaged and 9.6% understaged. Superficial cancer (stage T2) was diagnosed accurately in 100% of cases.

The ultrasound tendency to overstage superficial tumours which is more critical than to understage deep tumours has been reported [11]. This error rate may be an artificially inflated one, since ultrasound results are often compared with the results of cystoscopy and biopsy which frequently understage these tumours because the specimen in some cases does not include the whole thickness muscle wall. The importance of whole layer needle biopsy has been recently emphasized for exact staging of bladder cancer [12].

Computed tomography (CT) has been widely used in diagnosis and staging of bladder cancer because of its high sensitivity and relative non invasiveness. In this work, the CT findings were compared with those of ultrasonography in all patients and the results of both imaging modalities were correlated with pathological findings.

CT showed greater accuracy in delineation of extra vesical tumour spread (stages T3b and T4) with an accuracy rate of 91.2% compared to 78.9% of ultrasonography, however, CT showed a limited value in diagnosis of superficial cancer (stage T2) with 33.3% accuracy rate. This is probably related to the inability of CT to

differentiate various layers of the urinary bladder. The reported overall accuracy of CT in staging cancer was in one study 60% [13]. In another study [14], the reported accuracy rate was 76.9% with 60% sensitivity and 89.7% specificity. The staging accuracy for T2 tumours was 50% in this study. In our study the overall accuracy of CT was 83.5% with 12.3% being overstaged and 42% being understaged.

Poor definition of the borders of the urinary bladder with reticular appearance of the surrounding fat may suggest perivesical tumour extension on CT basis, however, the inability to differentiate between tumour invasion and other tissue changes secondary to inflammation, fibrosis of irradiation in the perivesical is a definitive disadvantage of CT [15, 8].

Detection of lymph node involvement by malignant disease will affect the tumour staging as well as the patient selection for surgery. In our study, CT was able to detect pathologically enlarged nodes in 10 out of 12 patients with surgically documented lymphadenopathy. False-ve results were obtained in 2 cases where CT did not show any pathological nodes that were discovered at surgery. This was attributed to microscopic involvement of normal sized nodes. No false +ve interpretations were made with an overall accuracy of 83.3%.

The facts that microscopic nodal metastases are not detected by any imaging modality [6] and that CT cannot distinguish between benign and malignant lymph node enlargement [4] are the major limitations for detection of lymph node metastases by CT and MRI. MRI was able to dectect pathological nodal involvement in two cases that were confirmed at surgery.

Increasing experience with magnetic resonance imaging (MRI) indicates that it may be helpful for the staging of bladder neoplasia [16]. In this work we evaluated 10 patients with MRI both before and after GD-DTPA (gadolinium-labeled diethylene-triamine-pentaacetic acid) enhancement. Four patients had post treatment MR examinations with an overall 14 examinations to clarify whether MRI could replace or be superior to computed tomography and/or ultrasonography for clinical staging as well as follow up of bladder cancer.

On the T1-weighted MR images the signal intensity of bladder tumour was equal to or slightly higher than that of the normal mucosa, urine or adjacent muscles and much lower than that of perivesical fat. The signal intensities of bladder mucosa and muscle were almost equal making the distinction between these two tissues impossible on the T1 weighted images. On the T2-weighted images the signal intensity of the tumour was equal or slightly lower than that of urine, so that the tumour detectability was degraded more so than the T1 weighted images. However, the signal intensity of the tumour was greater than

that of muscle and thus the tumour tissue could be distinguished from bladder muscle. The GD-DTPA enhanced T1 weighted images provided the most favorable results over the T1 and/or T2 weighted images. This was because GD-DTPA enhancement showed tumour, mucosa and submucosa as high signal intensity areas when compared to urine in the bladder or to the muscular tissue. Similar findings were also reported [17, 18].

The results of MRI are shown in tables 7,8. The overall accuracy of MRI in staging bladder cancer was 80% with 10% being overstaged and 10% understaged. The MRI accuracy in diagnosis of superficial tumours (stage T2) in our study was only 50%. The major cause of misdiagnosis of stage T2 tumours by MRI was over diagnosis to stage T3a which was probably due to over distension of the bladder wall resulting in a thin linear structure muscle layer leading to difficult judgement of the degree of muscle invasion [18].

The diagnostic accuracy of MRI and CT in clinical staging of bladder cancer were compared to histological results [8]. The MRI staging accuracy was 64% using the TNM calcification, while the CT accuracy was 40%. The study also concluded that CT and MRI were unable to differentiate superficial stage (T2) from deep muscle-invasive stage (T3a) tumours. More recently the results of transurethral ultrasonography, CT and MRI in preoperative staging of bladder cancer were compared and the reported accuracy rate was 81% for transurethral ultrasound, 80.8% for MRI and 76.9% for CT. It was concluded that MRI seemed able to overcome the disadvantage of ultrasound which tend to over diagnsoe superficial tumours and which was not suitable for use in correct diagnosis of infiltrative tumours [14].

Contrast enhanced MRI was used for evaluation of bladder neoplasms [17]. It was found that increase in tumour signal intensity on T1 weighted images was statistically significant after contrast enhancement using Gd-DTPA and resulted in simplifying the detection of tumours, however, evaluation of the extent of intramural infliteration was not possible even after contrast injection [17].

The staging of bladder cancer with Gd-DTPA enhanced MRI appears to be superior and more accurate than the staging obtainable by CT or transurethral ultrasound [18], however the accuracy of the degree of muscle invasion is still low even after enhancement, and potential developments with further improvements in the scanning techniques, surface coils and contrast materials are needed to provide an even more sophisticated diagnostic capability [18].

The role of ultrasonography may not be fully estimated in our study because we were not able to assess the value of the recently introduced transurethral and

transrectal ultrasound in evaluation of our patients, however, the data of other investigators [4] showed that transurethral ultrasound is more superior to other imaging modalities as far as local staging is concerned. Others reported that MRI is not as useful as transurethral ultrasound for local staging of bladder cancer [14]. A more recent study showed that Gd-DTPA enhanced MRI is superior and more accurate than the staging obtained by CT and transurethral ultrasonography [18]. The value of transrectal ultrasonography was more appreciated in prostatic and seminal vesicle invasion [6].

Post-therapeutic examinations were obtained in 19 patients using different imaging modalities for posttreatment evaluation. All patients were examined by ultrasonography, 10 patients by CT and 5 patients by MRI. The results are shown in table 9. The criteria for therapeutic response followed in this study were previously reported. These criteria indicated complete therapeutic response for the disappearance of all clinical, radiological and laboratory evidence of tumour. Partial response was defined as a reduction by 50% of the tumour diameters, while imrovement denotes reduction of the tumour size but less than partial response.

Stable disease means no increase in tumour size over a period of 6-7 weeks while receiving therapy. No therapeutic response means disease progression [19].

Post - operative examinations were performed in 4 patients by all imaging modalities, 3 of them had tumour recurrence that could be detected by US, CT and MRI which was able to detect lymph nodes involvement in one of these cases not detected by US or CT.

Fifteen patients were evaluated after chemo and/or radiotherapy. CT confirmed the ultrasonographic findings in 6 patients, one of them was evaluated by MRI as well. Post-therapeutic tumour residue or recurrence was documented by biopsy in all cases.

In this work MRI was slightly inferior to CT scan in staging of bladder cancer, however if the analysis is limited to the patients who were evaluated by all imaging techniques (10 patients), the MRI accuracy will be more than of CT and ultrasonography. The diagnostic value of ultrasonography for detection of lymph node metastasis is markedly limited, while it is more for both CT and MRI. All imaging techniques were complementary in post-therapeutic patient evaluation.

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