The Egyptian Journal of Radiology and Nuclear Medicine 49 (2018) 509–518

Contents lists available at ScienceDirect

The Egyptian Journal of Radiology and Nuclear Medicine

journal homepage: www.elsevier.com/locate/ejrnm

Original Article

Value of diffusion weighted magnetic resonance imaging in grading of urinary bladder carcinoma

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ARTICLE INFO

Keywords:
MRI
Diffusion
Urinary bladder cancer
Transitional cell carcinoma

ABSTRACT

Aim of the study: to evaluate the role of diffusion weighted magnetic resonance imaging in urinary bladder cancer grading in comparison to histopathological grading.

Patients and methods: This prospective study included 50 patients; 30 males and 20 females with mean age 66.4 years. All patients were referred clinically for bladder cancer and hence all of them underwent MR imaging. T2 weighted images were acquired followed by diffusion study in the same plane, b value = 800 s/mm^2.

Results: pathologic staging was between Tis and T1 (superficial) in 28% of tumors. More than T1 (Deep) in 72%. The mean ADC value was 1.203×10^{-3} with a standard deviation of $\pm 0.385 \times 10^{-3}$. The mean ADC value for stages Tis to T1 tumors was $1.505 \times 10^{-3} \pm 0.270$ SD; and stages T2 to T4 tumors was 1.085 ± 0.385 SD; $P < 0.001$. Cutoff ADC value was 1.275×10^{-3} as a useful indicator for differentiating stages Tis to T1 from T2 to T4; $P < 0.005$.

Conclusion: DW imaging is a noninvasive reliable modality for predicting histopathological aggressiveness of bladder cancer.

1. Introduction

Bladder cancer is the most common malignant tumor in the urinary tract among both men and women [1]. Clinical management of urinary bladder cancer is primarily based on distinguishing superficial tumors (stage T1 or lower) from muscle-invasive tumors (stage T2 or higher). Treatment options differ considerably between these two stages in which superficial tumors are treated with transurethral resection (TUR) with or without adjuvant intravesical chemotherapy or photodynamic therapy, whereas invasive tumors are treated with radical cystectomy, radiotherapy, chemotherapy or a combination [2].

Despite the European Association of Urology's guidelines still recommending computed tomography (CT) scan as the standard pre-operative imaging modality, CT showed many fallacies in up to 40% of cases [3]. CT can differentiate between tumor stages Ta to T3a, yet, even in cases with evident invasion of peri-vesical fatty tissue, accuracy ranges from 55% to 92% [4].

Dynamic magnetic resonance (MR) imaging was believed to be a more efficient and safer diagnostic modality than contrast enhanced CT – due to lack of exposure to ionizing radiation – for staging of bladder cancer [5]. However, over-staging has been found to be a commonly encountered problem during the use of dynamic MR imaging. Also, contrast media may cause adverse effects, such as nephrogenic systemic fibrosis (NSF). A better alternative for locoregional staging could be transurethral endoscopic ultrasonography, yet it is an invasive modality [6]. Hence, research studies for a safe, noninvasive diagnostic modality with a high diagnostic specificity should be sought for.

Diffusion weighted imaging (DWI) is an advanced, functional non-invasive radiological modality. It is highly sensitive in the detection of the random motion (Brownian motion) of water molecules and their collision against barriers like cell membrane. Thus, in cases of cellular overcrowding such as in malignancies, this motion well be restricted. DWI visualizes this motion; the more restricted the molecular motion inside the tissue, the higher the signal intensity on imaging will appear [7].

Peer review under responsibility of The Egyptian Society of Radiology and Nuclear Medicine.
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https://doi.org/10.1016/j.ejrnm.2018.01.015
Received 29 September 2017; Accepted 27 January 2018
Available online 04 May 2018

A value can be obtained for the degree of diffusivity of the displayed tissue, which is called apparent diffusion coefficient (ADC). It provides a quantitative parameter derived from DWI [8]. As for any other malignant tissue, bladder cancers also present high signal intensity on diffusion-weighted MR imaging, as well as low ADC value, which reflects restriction to Brownian motion inside the tissue [9].

Therefore, the objective of this research study is to evaluate the role of Diffusion weighted magnetic resonance imaging in urinary bladder cancer grading in comparison to histopathological grading.

2. Patients and methods

2.1. Patients

This prospective study was held in the period between March 2015 and March 2016, in a specialized Urology and Nephrology Center. It included 50 patients; 30 males and 20 females. Their ages ranged from 52 to 88 years, (The mean was 66.4 years). All patients were referred clinically for bladder cancer and hence all of them underwent MR imaging.

2.2. Inclusion criteria

Patients suspected to have urinary bladder carcinoma on basis of U/S and/or CT examinations.

2.3. Exclusion criteria

Patients who had contraindication for performing MRI e.g. claustrophobia, metallic implants or pacemaker, critically ill patients, or those who refused the study.

Histo-Pathological staging was performed for all patients after MRI examination as follows; all patients underwent trans-urethral biopsy with deep muscle component at the center of the tumor. If the core was negative for tumor cells, histo-pathological staging was determined to be stage T1 or lower, while if tumor cells were found in the biopsy, tumor grade were shifted into invasive bladder cancer. Patients underwent radical cystectomy within 20 days (at maximum) after MR imaging was done (mean, 5 days).

2.4. MR imaging

To moderately distend the bladder, patients were instructed to start drinking water one hour before MRI examination and not to void prior to the examination. In those with catheterized urinary bladder, 250–400 mL of saline was infused inside the bladder to achieve distention.

The scanner used to perform examinations was a 1.5-T MR scanner; (SIGNA Horizon, General Electric Medical Systems, Milwaukee, WI). The coil used was a radiofrequency coil; (Quadrature body coil; General Electric Medical Systems).

2.5. Image processing

Bladder fullness was ensured on the obtained scout images prior to the actual image acquisition. Initially, Axial, Sagittal and Coronal - High resolution - T2 weighted images (T2WIs) of the pelvis were acquired; Repetition time (TR) 6000 ms, Echo time (TE) 102 ms, Matrix 256 × 16, FOV 22 cm, Slice thickness 3.5 mm, Intersection gap 1 mm, NEX 3. Then, with the patient freely breathing, Diffusion weighted images (DWIs) were obtained in the axial plane by using a mono-directional gradient multi-section fast spin-echo echoplanar sequence in axial plane; Repetition time (TR) 8000 ms, Echo time (TE) is minimum for b value = 800 s/mm^2, Matrix 128 × 128, FOV 34 cm, Slice thickness 5 mm with no intersection gap, NEX 2. 30 to 55 sections were obtained in 60–120 s to cover the pelvis.

In some cases, DWIs were acquired in the sagittal plane to be perpendicular to the tumor base. T2WIs were acquired in the same plane as the diffusion images. To gain better signal-to-noise ratio (SNR) in DWIs, we used a larger field of view than in T2-weighted images.

Table 1
TNM staging of urinary bladder cancer [10,11].

Jewett-Strong	TNM stage	Definition
0	Tx	Primary tumor cannot be assessed
0	T0	No primary tumor
0	Ta	Non-invasive papillary carcinoma
0	Tis	Carcinoma in situ
A	T1	Tumor invades connective tissue under the epithelium (surface layer)
B	T2	Tumor invades muscle
B1	T2a	Superficial muscle invaded (inner half)
B2	T2b	Deep muscle invaded (inner half)
C	T3	Tumor invades peri-vesical fat
	T3a	Tumor is detected microscopically
	T3b	Extravesical tumor is visible macroscopically
D	T4	Tumor invades the prostate gland, uterus, vagina, pelvic wall, or abdominal wall
	T4a	Tumor invades prostate, uterus, or vagina
	T4b	Tumor invades pelvic or abdominal wall
	Node	
	Nx	Regional lymph nodes cannot be evaluated
	N0	No regional lymph node metastasis
D1	N1	Metastasis in a single lymph node < 2 cm in size
D1	N2	Metastasis in a single lymph node < 2 and > 5 cm in size, or multiple lymph nodes < 5 cm
D1	N3	Metastasis in a lymph node > 5 cm
	Metastasis	
	Mx	Distant metastasis cannot be evaluated
	M0	No distant metastasis
D2	M1	Distant metastasis

2.6. Image interpretation

MR interpretation and reporting was blinded from any histopathological information. Finally, data obtained from MR images were compared with histopathologic findings following the biopsy. Urinary bladder tumors were classified into four stages as mentioned with TNM classification from the American Joint Committee on Cancer (Table 1, Fig. 1).

On T2 weighted images, normal vesical wall appears as a continuous line of low SI,