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Comparative Study between Pre- and Post-IV Contrast MDCT Urography in Characterization of Neoplastic Urinary Bladder Masses

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Abstract

Background: Bladder cancer is one of the most common tumors of the lower urinary tract. It is the seventh most common malignancy that is found to be widely spread in developed countries.

Aim of Study: Is to compare pre- and post-contrast multidetector CT urography findings in detecting and characterizing urinary bladder neoplastic masses, using cystoscopy results as the gold standard for comparison.

Patients and Methods: This comparative study was conducted on thirty patients, 25 men and 5 women. Over a six-month period, the patients were referred to the radiology department at Kasr Alainy University Hospitals. Patients with suspicious bladder mass(es) after clinical evaluation or for further characterization of an indeterminate bladder neoplastic mass lesion previously detected by other radiological investigation such as ultrasound examination were included in the study.

Results: There was a non-significant (p=0.537) difference in the lesion size pre-contrast (8.76±9.1) compared to post-contrast (8.79±9.0) MDCT studies. Both measurements had the same distribution regarding the site and morphology of the lesions. Both measurements had insignificant (p=0.101) difference in the distribution regarding extension of lesion. There was a significant (p=0.009) difference in the distribution regarding other findings of lesions (regional lymph nodes enlargement and back pressure changes).

Conclusion: MDCT, pre- and post-contrast sequences, are completing each other in the detection and characterization of neoplastic bladder masses, with the conventional cystoscopy (CC) is still the gold standard for the evaluation of urinary bladder masses.

Key Words: *Cancer bladder – MDCT urography – Urinary bladder neoplasm staging.*

Introduction

URINARY bladder cancer is the fourth most common cancer in males and the tenth most common cancer in females. It is common in males aged 50-70 years and is mostly related to smoking or occupational exposure to carcinogens. Urinary bladder neoplasms are classified as either epithelial or non-epithelial, with over 95% being epithelial. Urothelial tumors exhibit a spectrum of neoplasia, ranging from a benign papilloma through carcinoma in situ to invasive carcinoma [1].

One of the typical signs of bladder cancer is painless hematuria. CT is a recommended radiologic approach to assessing hematuria. To depict even small bladder lesions, optimal imaging conditions, including adequate bladder distention and thin-slice scanning, must be fulfilled [2].

In recent years, CT technology has undergone rapid development, leading to an improvement in the diagnostic accuracy of bladder neoplasms. Since its first use, CT cystography has demonstrated promising results for the diagnosis of bladder lesions. The development of 16-64 MDCT scanners greatly improved spatial resolution by the use of

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List of Abbreviations:

CC	: Conventional Cystoscopy.
CIS	: Carcinoma In Situ.
CT	: Computed Tomography.
CTU	: Computed Tomography Urography.
DCE	: Delayed Contrast Enhancing.
HU	: Hounsfield Unit.
HUN	: Hydro-Uretero-Nephrosis.
IVU	: Intravenous Urography.
LN(s)	: Lymph Node(s).
Lt.	: Left.
MDCT	: Multidetector Computed Tomography.
MIP	: Maximum Intensity Projection.
MPR	: Multi-Planar Reformatted.
Rt.	: Right.
SCC	: Squamous Cell Carcinoma.
SD	: Standard Deviation.
TCC	: Transitional Cell Carcinoma.
UCC	: Urothelial Cell Carcinoma.
VUJ	: Vesico-Ureteric Junction.
WHO	: World Health Organization.

thinner slice thickness, collimation, and reconstruction increment, which enabled fast execution and high resolution of the examination. Moreover, it allows the acquisition of multiplanar reformatted images (MPR), which is very similar to that of the axial plane. Combined evaluation by CT cystography, MPR, and virtual images has been shown to increase the effectiveness of the technique, especially for the detection of small lesions [1].

One of the most common procedures in urology is conventional cystoscopy. It is the gold standard for detecting pathology in the urinary bladder and for follow-up after bladder tumor treatment. The vast majority of cystoscopies are performed with a flexible or rigid instrument under local anesthesia, so the procedure is considered an invasive one. Moreover, it has no value in diagnosing extravesical lesions [3].

The aim of this study is to compare pre- and post-contrast multi-detector CT urography in detecting and characterizing urinary bladder neoplastic masses, using cystoscopy results as the gold standard for comparison.

Patients and Methods

This study is a comparative cross-sectional study between pre- and post-contrast MDCT studies in the detection of urinary bladder masses.

Patients:

This study included 30 patients; 25 men and 5 women. The patient ages range was between 31 and 84 years old. It was done at The Radiology Department, Cairo University Hospitals in the period between June and October 2022.

Inclusion criteria:

- All patients referred from the urology department and were clinically suspected of having a bladder.
- Both sexes were included.
- Patients above 30 years old presenting with painless gross hematuria.

Exclusion criteria:

- Patients with impaired renal function (creatinine >2mg/dl).
- Patients with hypersensitivity to iodinated contrast media.
- Pregnant women.

Methods:

A- *Sample size and sampling:*

This study included 30 patients who met the study's criteria. We utilized a convenient sampling technique to choose the patients from The Radiology and Urology Departments.

B- Study's procedures and data collection:

Each eligible patient underwent the following:

- Full history taking, personal data (name, sex, age, address, occupation, and special habits in particular smoking), and clinical data (hematuria, pubic pain, fever, dysuria), including the following: The onset, course, and duration of the main complaint.
- Past history of bilharzia infection and occupation.
- Laboratory assessment.
- Pre- and post-contrast multiphasic CT images.
- Compare the results of pre- and post-contrast pelviabdominal CT.
- Correlation with the cystoscopy and histopathology results.

C- CT protocol:

CT examinations were performed using the Siemens Emotion 16 slices (2010), serial number 78829. Venous access to inject the contrast was positioned in an antecubital vein of the arm by means of an 18- to 20-gauge needle cannula.

The first acquisition without contrast injection was performed cranio-caudal from the diaphragm to the perineum. Two scans were performed after the injection of non-ionic water-soluble iodinated contrast (Iopromid Ultravist Schering) in the cranio-caudal direction too. The post-contrast acquisition was obtained in the nephrogenic phase after 60-90 seconds and the delayed phase after 5-15 minutes.

The image analysis and post-processing data sets were transferred to an advantage workstation in real-time, and MPR was performed in the sagittal and coronal planes for each scan.

D- Imaging analysis:

Images were analyzed blindly by two radiologists who were not aware of the patients' presentations.

For lesion identification, each radiologist had to report the presence or absence of a lesion. We compare each lesion in the pre- and post-contrast study using the following parameters: lesion site (bladder dome, walls, and trigone), size, morphology, enhancement pattern, extension (peripheral fat stranding and back pressure changes), and if there are other associated findings (lymph node enlargement). Findings detected by CT were compared to the cystoscopy result.

E- *Statistical analysis:*

Data were verified, coded by the researcher, and analyzed using IBM-SPSS 24.0 (IBM-SPSS Inc., Chicago, IL, USA)

Descriptive statistics:

Means, standard deviations, medians, ranges, frequency, and percentages were calculated. Mc-Nenar test was used to compare the difference in the distribution of frequencies on repeated measures (pre- vs. post-contrast). Weighted Kappa was used to detect the level of agreement between the two events. A significant *p*-value was considered when it is <0.05.

Results

This comparative cross-sectional study was conducted in the Diagnostic and Interventional Radiology Department, Faculty of Medicine, Cairo University, in the period from June 2022 to October 2022. This study involved 30 patients. The patient ages range was between 31 and 84 years old[mean, SD: 64.30, 9.4], with suspected urinary bladder neoplastic masses. The majority of the patients (83.3%) were males (n=25) (Fig. 1).

Regarding the clinical presentation, most of the patients (23 patients, 77%) presented with painless haematuria, 3 patients (10%) had haematuria with left loin pain, 2 patients (6.7%) had haematuria with right loin pain, and 2 patients (6.7%) had haematuria with difficulty in micturition (Fig. 2).

Comparing pre- and post-contrast CT images regarding the urinary bladder mass size showed a non-significant (p=0.537) difference in measuring the lesion size (Table 1) (Fig. 3).

On the other hand, both CT sequences had some, yet insignificant (p=0.101), differences in the distribution regarding extension of the urinary bladder lesions (Table 2).

However, there was a significant (p=0.009) difference in the distribution regarding other findings, such as the detection of extra vesical fat stranding and the presence of pelvic lymph nodes (Table 3) (Figs. 4,5,6).

Pathology findings data are presented in (Table 4) that demonstrated that the most common diagnostic entity was invasive urothelial carcinoma Grade III with muscle invasion (36.7%).

Table (1): Comparison between pre- and post-contrast MDCT urography regarding the urinary bladder mass size.

	(n=30)		*p*-value
	Pre-Contrast	Post-Contrast	
Lesion Size:			
Mean SD	8.76±9.1	8.79±9.0	=0.537*
Median (Range)	5 (1.6-38.3)	5 (1.6-38.3)	
- Interclass Correlation (ICC)		=0.999	<0.001

*Related Sample Wilcoxon Sign test was used to compare the median for contrast.

Table (2): Comparison between pre- and post-contrast MDCT urography regarding the urinary bladder mass extension.

	(n=30)		*p*-value
	Pre-Contrast	Post-Contrast	
Extension:	No. of patients (percentage)	No. of patients (percentage)	0.101*
- No Extension	6 (20%)	6 (20%)	
- Not Well Identified	7 (23.3%)	0 (00%)	
- Encroaching on the Lt. VUJ	4 (13.3%)	4 (13.3%)	
- Encroaching on the Rt. VUJ	3 (10%)	4 (13.3%)	
- Peri-vesical Fat Stranding	0 0 (0%)	8 (26.7%)	
Weighted Kappa Agreement	=0.643 (<0.001)		

*Mc Nemar test was used to compare the frequency differences for Repeated Measures.

Table (3): Comparison between pre- and post-contrast MDCT urography in cases with urinary bladder masses regarding associated findings.

	(n=30)		*p*-value
	Pre-Contrast	Post-Contrast	
Other Findings:	No. of patients (percentage)	No. of patients (percentage)	=0.009*
- No Other Findings	14 (46.7%)	10 (33.3%)	
- Rt. HUN	4 (13.3%)	4 (13.3%)	
- Lt. HUN**	4 (13.3%)	4 (13.3%)	
- Peri-vesical Fat Stranding	0 (0%)	8 (26.7%)	
- Iliac/Para-aortic LNs	0 (0%)	2 (6.7%)	
- Pelvic LNs	0 (0%)	2 (6.7%)	
Weighted Kappa Agreement	=0.819 (<0.001)		

*McNemar test was used to compare the frequency differences for Repeated Measures.

Table (4): Pathology Results of the studied Cohort.

Pathological Category	No of patients (percentage)
- Invasive Urothelial Carcinoma GIII with Muscle Invasion	11 (36.7%)
- Papillary Urothelial Carcinoma Low GII with No Muscle Invasion	6 (20%)
- Non-invasive Papillary Urothelial Carcinoma Low-Grade, No Muscle Invasion	4 (13.3%)
- Invasive Squamous Cell Carcinoma	2 (6.7%)
- Papillary Urothelial Carcinoma Low GI with No Muscle Invasion	2 (6.7%)
- Papillary Urothelial Carcinoma Low GIII with No Muscle Invasion	2 (6.7%)
- Invasive Urothelial Carcinoma GI with Muscle Invasion	1 (3.3%)
- Invasive Urothelial Carcinoma GII with Muscle Invasion	1 (3.3%)
- Invasive Urothelial Carcinoma GIII with No Muscle Invasion	1 (3.3%)

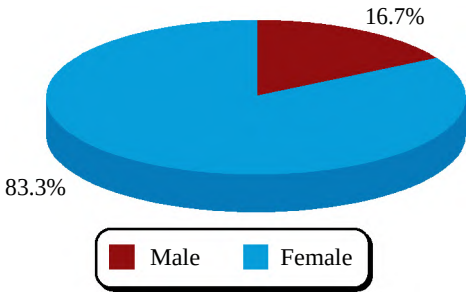

Fig. (1): Sex Distribution of the study patients.

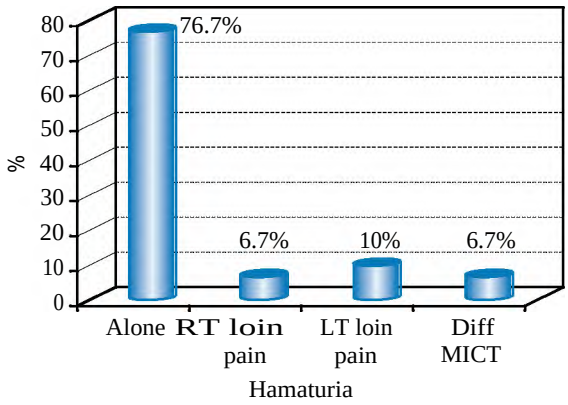

Fig. (2): Distribution of the symptoms among the study patients.

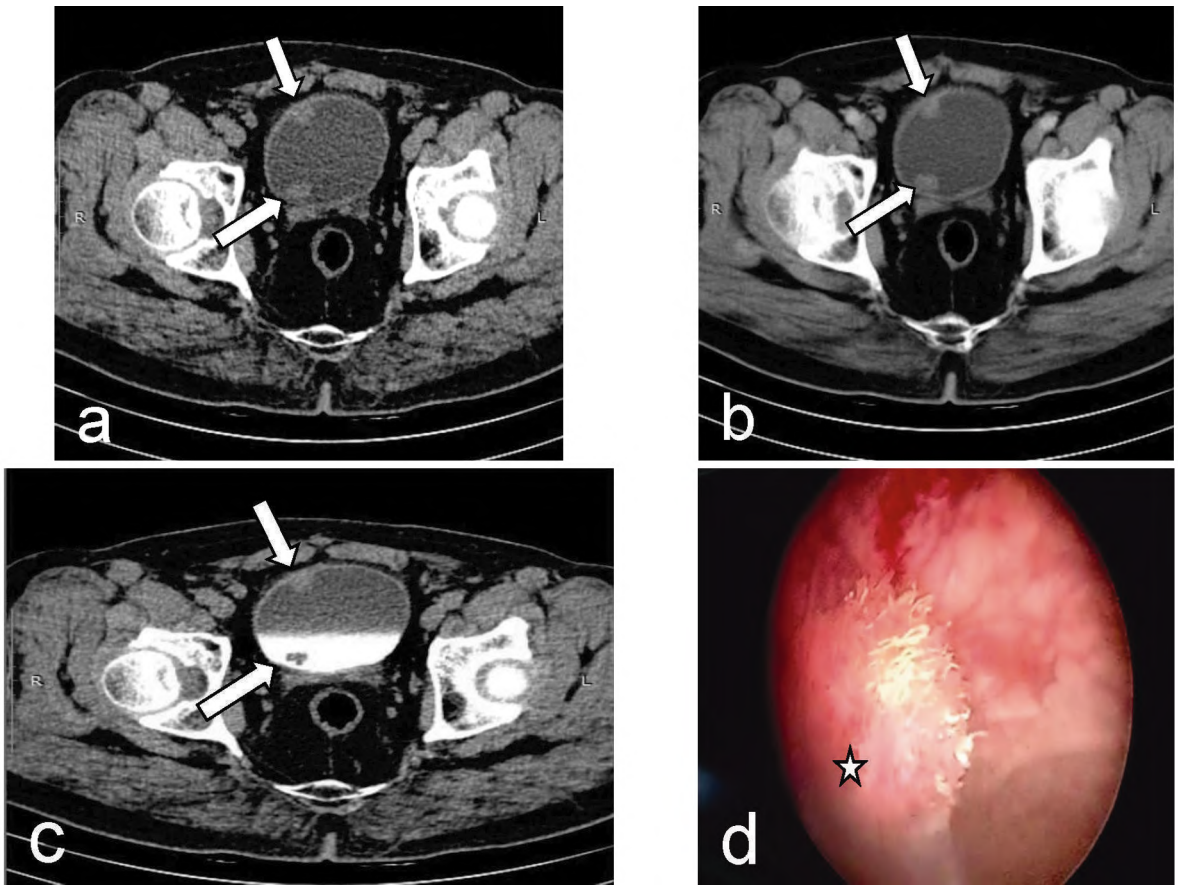

Fig. (3): (A) Pre-contrast, (B) Early post-contrast, (C) Delayed post-contrast axial MDCT showing two polypoidal lesions (arrows) seen at the right anterolateral wall and right posterolateral wall of the urinary bladder with no significant difference regarding the detection of their sizes or locations in the pre- and post-contrast series. (D) Conventional cystoscopy image confirmed the same findings (star). Diagnosis: Non-invasive papillary urothelial carcinoma (low grade, no muscle invasion).

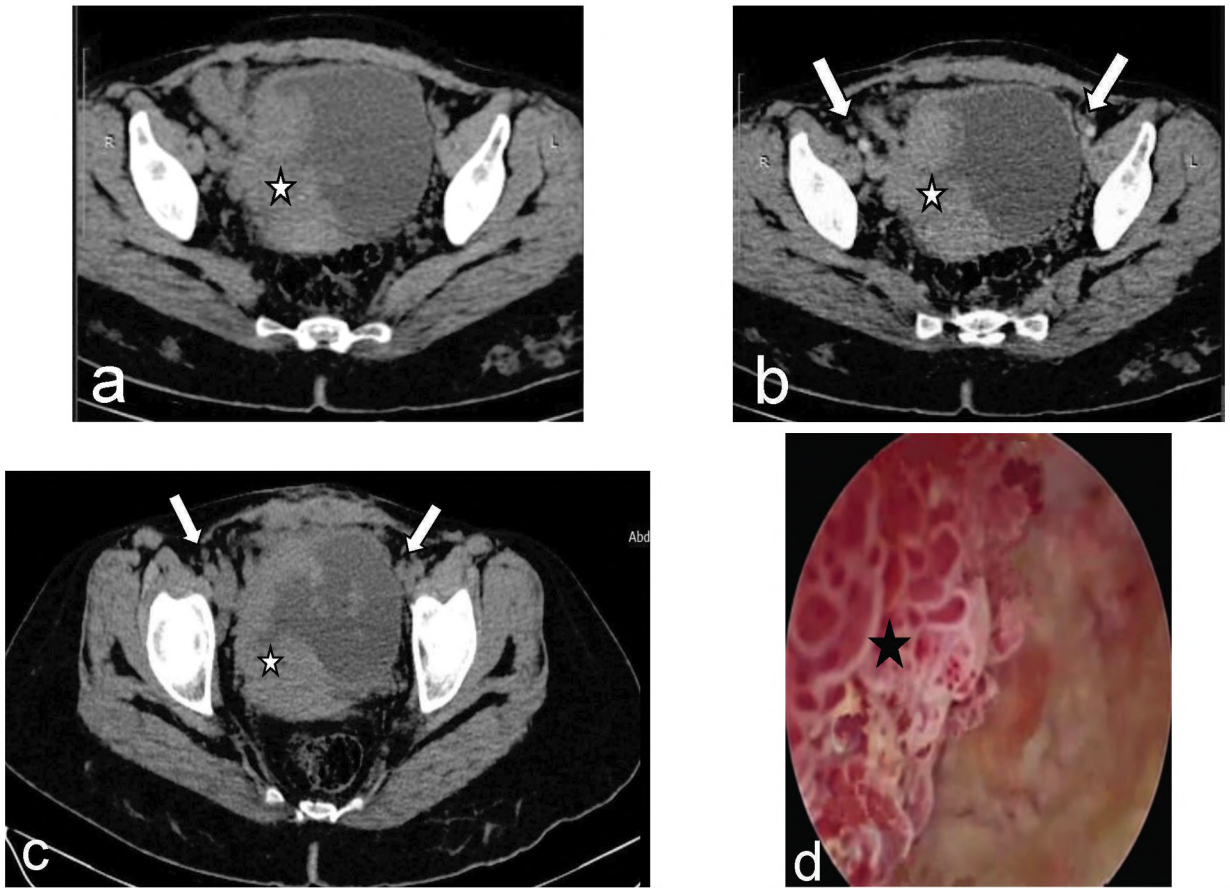

Fig. (4): (A) Pre-contrast, (B,C) Early post-contrast axial MDCT showing irregular polypoid urinary bladder soft tissue mass involving its anterior, right lateral walls and (white stars). Bilateral enlarged external iliac lymph nodes measuring about 1cm in short axis diameter each are evident in the post contrast series (arrows). (D) Conventional cystoscopy image showing the endophytic papillary bladder mass (black star). Diagnosis: Invasive squamous cell carcinoma.

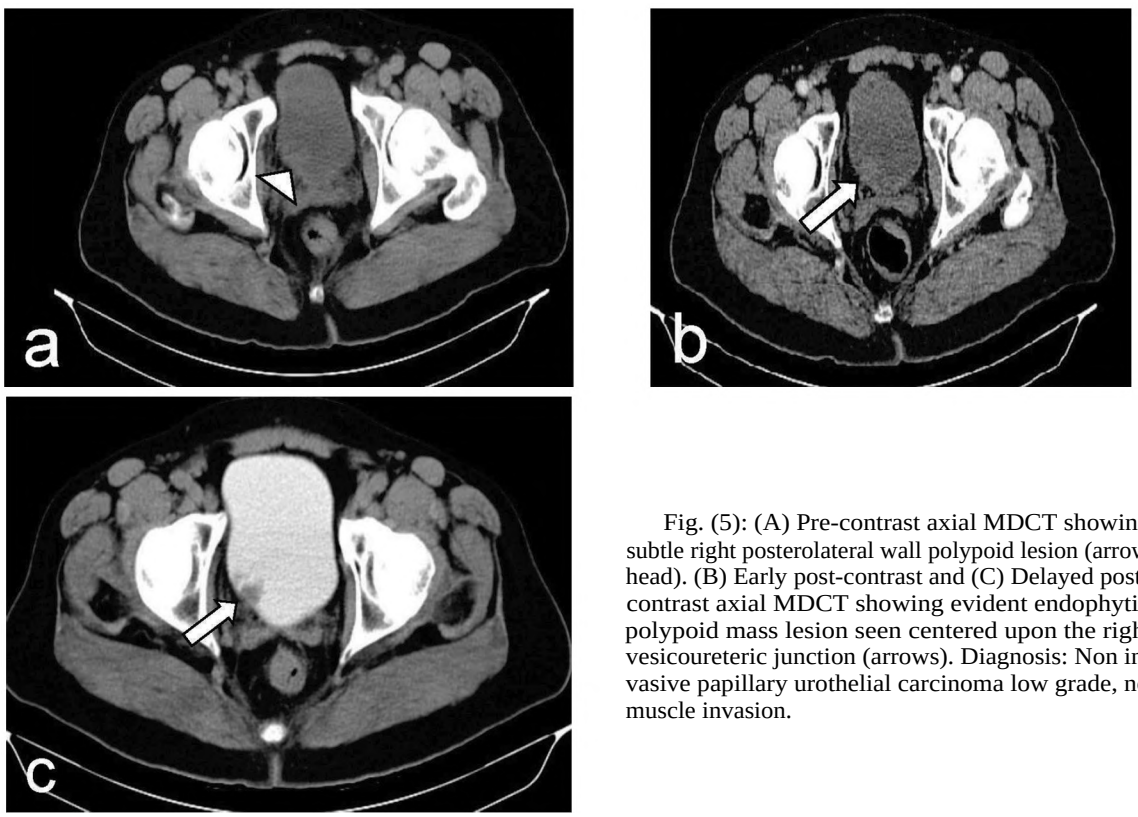

Fig. (5): (A) Pre-contrast axial MDCT showing subtle right posterolateral wall polypoid lesion (arrow head). (B) Early post-contrast and (C) Delayed post-contrast axial MDCT showing evident endophytic polypoid mass lesion seen centered upon the right vesicoureteric junction (arrows). Diagnosis: Non invasive papillary urothelial carcinoma low grade, no muscle invasion.

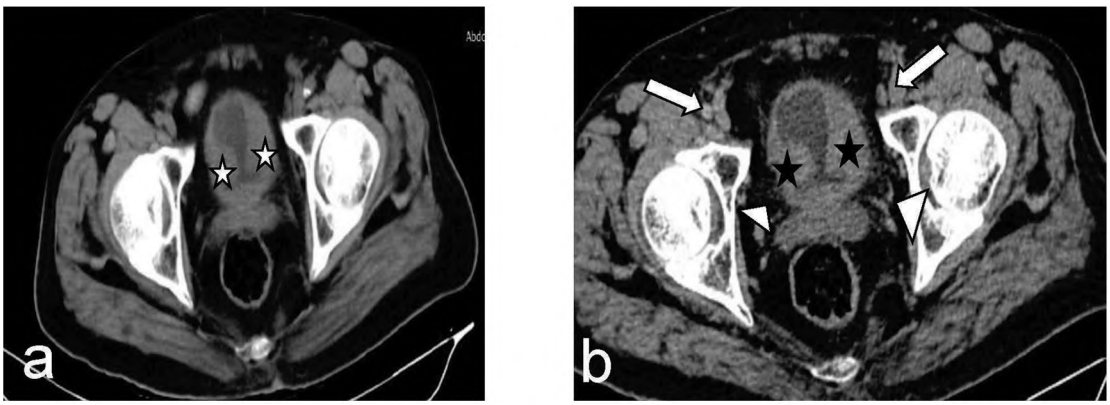

Fig. (6): (A) Pre-contrast axial MDCT showing urinary bladder irregular mural thickening mounting to endophytic soft tissue mass lesion more evident at bilateral lateral and posterior walls (white stars). (B) Early post-contrast axial MDCT showing irregular enhancing mural thickening mounting to endophytic soft tissue mass lesion involving both lateral and posterior urinary bladder walls (black stars) with prominent subcentimetric iliac lymph nodes (arrows) and evident perivesical fat stranding (arrow heads). Diagnosis: Papillary urothelial carcinoma grade 3.

Discussion

Urinary bladder cancer is the second most common urogenital. It comes before prostatic cancer regarding worldwide prevalence. It is the 10th most widely spread cancer in the world [4]. The incidence of bladder cancer rises with age, and it is higher in males than females by about 3-4 times. The most important risk factor is cigarette smoking [5].

Painless hematuria is the most common symptom of bladder cancer [6]. In our study, painless hematuria accounted for 77% of cases, while hematuria with other symptoms accounted for 23%.

CT urography is a valuable imaging modality for assessing patients with risk factors for urologic malignancy and for other indications, such as gross hematuria [7]. The development of 16-64 MDCT scanners significantly improved spatial resolution by using thinner slice thickness, collimation, and reconstruction increment, which enabled quick execution and high resolution of the examination. Since its initial application, CT cystography has shown promising results for the diagnosis of bladder lesions. Additionally, it enables the acquisition of Multiplanar Reformatted Images (MPR) that resembles planar axial images. Combining CT cystography, MPR, and virtual pictures has been demonstrated to be effective particularly for spotting tiny lesions [8].

Our study included thirty patients aged above thirty years old who presented mainly with hematuria. The MDCT was performed for all patients with three phases; pre-contrast and post-contrast (early and delayed phases) in order to assess the value of post-IV contrast CTU images compared to the non-enhanced CTU images.

In our study, 17 patients (56.7% of cases) showed irregular wall thickening and 13 lesions (43.3%) to be polypoidal mass lesions on CT in both pre- and post-contrast phases. In a study done by Ola et al., in 2019, only 16 patients out of a total of 40 patients (40%) had irregular urinary bladder wall thickening [1]. In another study performed by Capalbo et al., in 2015, irregular urinary bladder wall thickening showed in 38 cases (21%) and polypoid mass in 72 lesions (40%) of a total of 177 lesions [9].

In our study, both CTU phases; pre- and post-contrast CT, have the same findings regarding the site of the lesions, as 7 lesions (23.3%) were anterior in location, 4 lesions (13.3%) were posterior in location, 9 lesions (30%) were located at the left lateral wall, 9 lesions (30%) involved the right lateral and 2 lesions (2.6%) were seen as dome lesions. In comparison to the study performed by Elawady et al., 2016, it was done on thirty patients, that revealed 3 (10%) anterior lesion locations, 5 (16.6%) posterior lesion locations, 6 (20%) left lateral lesion locations, 3 (10%) right lateral lesion locations and 2 (6.6%) dome lesion locations [10].

On the other hand, in our study, both pre- and post-contrast CTU studies had significant differences (p=0.009) regarding the detection of other findings associated with the urinary bladder mass, mainly extravesical findings such as the regional enlarged lymph nodes. In pre-contrast study, no cases were detected while in post-contrast study 4 cases (13.3%) were found to have pelvic or parailiac lymph node enlargement. As compared to the results of Ola et al., [1]. Regional lymph nodes were identified in post-contrast CT study in 6 out of 30 cases (20%).

One other important finding is the presence of associated hydronephrosis which showed no difference between pre- and post-contrast studies in our study. Both pre- and post-contrast CT studies showed that 12 out of 30 cases (40%) had hydronephrosis in comparison to the results of Niazie et al., **[11]**, in which hydronephrosis was identified in 6 out of 30 patients (20%).

In our study, the perivesical fat stranding was found in 8 cases (26.7%) in post-contrast study that was not properly identified in the pre-contrast study. In the study done by Ola et al., **[1]**, perivesical fat stranding was found in 11 cases (36.7%) that was also identified in only the post-contrast studies.

Histopathological results in our study revealed that 2 lesions (6.6%) were squamous cell carcinoma and 28 lesions (93.3%) were urothelial carcinoma. 14 cases of them were invasive type while 14 cases were non-invasive. In the study done by Niazie et al., **[11]**.

Histopathological results revealed that 8 lesions (21 %) were squamous cell carcinoma, 25 lesions (65.7%) were urothelial carcinoma and 5 lesions (13.1%) were non-neoplastic

Conclusions:

In conclusion, pre-contrast MDCT cannot completely replace post-contrast MDCT in the detection and characterization of urinary bladder neoplastic masses. Both studies are completing each other. Pre-contrast study can detect the bladder mass but cannot give us accurate information about the extra vesical extension and regional lymph node involvement. However, conventional cystoscopy (CC) remains the gold standard for the evaluation of urinary bladder masses, yet with limitations regarding its value in the assessment of the extravesical involvement.

Declarations:

Ethics approval and consent to participate.

No personal data was included in the study.

This study was approved by the Research Ethics Committee of Faculty of Medicine, Cairo University on 20th June 2022. Reference number of approval: MS-155-2022.

All patients participating in this study were informed of what it entails and gave informed consent to take part in this research.

If the patient was unconscious at the time of the study, written informed consent for their participation was provided by their legal guardian.

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دراسة مقارنة بين التصوير بالأشعة المقطعية متعددة المقاطع قبل وبعد الصبغة فى الكشف عن وتوصيف الكتل السرطانية للمثانة البولية

يعتبر سرطان المثانة البولية واحداً من أكثر الأورام شيوعاً بين المسالك البو لية السفلية، هو السابع من حيث الانتشار ومنتشر على نطاق واسع فى البلاد المتقدمة.

وتعتبر الأشعة المقطعية متعددة المقاطع من أهم الطرق التشخيصية لسرطان المثانة البولية من حيث سرعة الفحص وراحة المريض دون التعرض لآثار جانبية قد تكون خطيرة.

وفى هذه الدراسة نقوم بالمقارنة بين التصوير بالأشعة المقطعية متعددة المقاطع قبل وبعد الصبغة فى الكشف وتوصيف الكتل السرطانية للمثانة.

ويستخدم منظار المثانة التقليدى فى تشخيص ومتابعة سرطان المثانة ولكنه مكلف ويستغرق وقتاً طويلاً، وقد يعرض المريض لبعض الآثار الجانبية مثل التهابات المسالك البولية أو ثقب جدار المثانة أو ضيق فى مجرى البول ولكنه يبقى هو المعيار الذهبى لتشخيص الكتل السرطانية للمثانة البولية.

وقد أظهرت هذه الدراسة ضرورة إجراء كلا الفحصين بالأشعة المقطعية متعددة المقاطع قبل وبعد الصبغة حيث أنهما يكملان بعضهما فى التوصيف الدقيق للكتل السرطانية للمثانة البولية.