ROLE OF MULTIDETECTOR COMPUTED TOMOGRAPHY VIRTUAL CYSTOSCOPY IN EVALUATION OF URINARY BLADDER CARCINOMA

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Abstract Objective: To evaluate the diagnostic possibilities of multidetector computed tomography (MDCT) virtual cystoscopy (V.C.) in evaluation of urinary bladder carcinoma.

Patients and methods: This study included 55 patients with recent initial conventional cystoscopic (C.C.) assessment (at the outpatient clinics) & revealed bladder mass including the followed up patients for U.BL. mass recurrence who were referred for CT virtual cystoscopic (V.C.) evaluation. All patients underwent conventional cystoscopy within a week after the virtual examination. The virtual image, axial 2D, and C.C. reports were compared to each other and to the obtained histopathological results.

Results: Out of 93 intravesical masses depicted by C.C., 91 were depicted by V.C. (97.8%). The CT V.C. had higher sensitivity (97.8%) in comparison to that of axial 2D spiral CT (90.3%) in

Keywords Multidetector CT; CT virtual cystoscopy; Conventional cystoscopy; Urinary bladder

Abbreviations: MPR, multiplanar reconstruction; MDCT, multidetector CT; V.C., virtual cystoscopy; C.C., conventional cystoscopy; U.BL., urinary bladder; UT, urinary tract; SCC, squamous cell carcinoma; TCC, transitional cell carcinoma.

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1. Introduction

Urinary bladder carcinoma is the most common tumor of the urinary system (1). Several risk factors have been accused as being involved in its pathogenesis such as cigarette smoking, synthetic nitrogen fertilizers, aromatic amines, pelvic irradiation, a cyclophosphamide, chronic cystitis, Schistosomiasis, human papilloma virus, genetic predisposition, and some occupations. The relative importance of such risk factors in the pathogenesis of the disease differs in different populations (2).

In Egypt, U.B.L. carcinoma has been the most common cancer during the past 50 years. Interestingly, the most common histopathological type of bladder cancer in Egypt has been squamous cell carcinoma (SCC). Contrary to the leading etiology of smoking and occupational exposures in Western countries, chronic bladder infection with Schistosoma haematobium has been the most important risk factor for urinary bladder carcinoma in Egypt. Bladder cancer in Egypt has significantly changed within the last 26 years. Reductions in Schistosomal infection and increase in cigarette smoking and chemical exposures related to occupational hazards have resulted in changing pattern of bladder cancer in Egypt, so, transitional cell carcinoma (TCC) has become the most frequent type (3).

Conventional cystoscopy (C.C.) is a standard diagnostic approach for urinary bladder evaluation. There are several disadvantages of the C.C., including its high cost and invasiveness. It is often difficult to perform adequately when exploring the anterior bladder wall or a diverticulum cavity. There are some contraindications for the conventional cystoscopy such as bacteruria, acute cystitis, urethritis, prostatitis, obstructive prostatic hypertrophy, hematuria and stricture or rupture of the urethra (4).

The reported staging accuracy of conventional CT in staging of urinary bladder carcinoma is as low as 40–60% (5,6). Conventional CT cannot distinguish non-muscle invasive from muscle-invasive bladder cancer, also cannot detect microscopic perivesical spread of tumor. Detection of macroscopic tumor extension can also be problematic. Perivesical soft-tissue stranding is a nonspecific finding and can be due to tumor or merely edema (7).

The introduction of multidetector CT (MDCT) scanners was a major technologic advance because, among other things, it substantially improved z-axis (longitudinal) resolution by reducing section collimation and facilitating detection of very small lesions. The near isotropic pixels achieved with a 16-MDCT scanner enable acquisition of multplanar reformatted (MPR) images with resolution very close to that of axial images and 3D renderings of outstanding quality. Use of a 64-MDCT scanner can improve image quality by further improving spatial resolution (8).

Virtual endoscopy is a recently developed non-invasive method to detect tumors protruding from the walls of hollow organs. A promising advantage of this imaging modality is that views not possible in conventional endoscopic examination can be created. The volumetric data obtained with helical CT imaging are computer-rendered to generate three-dimensional images, and with commercially available software, intraluminal navigation through any hollow viscus is possible (4).

Computed tomography virtual cystoscopy (CT V.C.) has known advantages in the evaluation of urinary bladder neoplasms. It is a minimally invasive technique and is not associated with the complications reported with conventional cystoscopy. It allows imaging of the urinary bladder in multiple planes and a 360° view, which is not possible with C.C. With CT V.C., the radiologist acquires information about the location, size, and morphologic features of the lesions and conveys it to the surgeon performing cystoscopy, indicating appropriate areas for evaluation and biopsy. CT V.C. can be performed in cases in which C.C. is not feasible (8).

2. Patients and methods

2.1. Patient population & ethical consideration

This study was approved by the local research & ethical committee of Urology & Nephrology center, Faculty of Medicine, Mansoura University. The aims, methods and limitation of the technique were described to every case before doing the examination.

This study included 55 patients with recent initial C.C. assessment (at the out-patient clinics) of the U.B.L. which revealed the presence of U.B.L. mass including patients coming for follow up for the presence of recurrence.

The investigated patients were divided into two groups according to examination technique:

*Group I:* included 50 patients who were subjected to spiral CT of the bladder after air insufflation by a urinary catheter, with virtual CT cystoscopy reconstruction, then to intraoperative conventional cystoscopy. The virtual pictures, the CT findings, as well as conventional cystoscopic pictures and reports were compared to each other and to the obtained histopathological results.

*Group II:* included 5 patients & subdivided into two subgroups; (G.IIa.) which included two patients with urethral stricture, not subjected to air insufflation because catheterization was not amenable, they underwent MDCT of the bladder after IV contrast administration and waiting the bladder to be filled with contrast, then they underwent CT virtual cystoscopy reconstruction. The virtual pictures,
the CT findings, as well as conventional cystoscopy pictures and reports were compared to each other and to the obtained histopathological results. (G.IIb.) included three patients in whom, the conventional cystoscopy could not reach interior of diverticulum with a small opening. These patients underwent MDCT of the bladder after air insufflation with virtual CT cystoscopy reconstruction. Our results were confirmed by histopathological studies.

2.2. Methods

2.2.1. Study equipment and technique

All CT examinations were done using a multidetector CT scanner with 64 parallel detector-rows.

All patients were subjected to the following:

1- Detailed history taking with special emphasis on the complaint of the patient and present illness.
2- Full general examination and local examination.
3- Routine laboratory investigations, including urine analysis, full blood picture and renal function tests.
4- Routine cystoscopy (conventional cystoscopy examination) was performed for every patient, under general anesthesia with biopsy specimens obtained from the bladder masses.
5- CT scanning of the pelvis.

A) For the cases examined with air contrast in the bladder:
   = Just prior to scanning, the bladder was catheterized. The catheterized bladder was completely evacuated from urine, followed by insufflation of the bladder by 300–500 ml room air via the catheter, using 50 ml. syringe and a clamp (according to the bladder and patient tolerance).
   = An anteroposterior scout view of the pelvis was obtained to plan the MDCT scan.
   = A single breath-hold spiral axial CT scanning of the pelvis was then performed using the following parameter (Tube current; 250 mAs., Tube voltage; 120 KVP, Slice thickness; 0.9 mm, Collimation; 64×0.625. A beam pitch; 1.078). NB: The patient was examined in both supine and prone positions. Imaging in both positions is necessary for visualization of the entire mucosal surface without obscuration caused by residual urine. This was restricted to the patients who still had significant amount of residual urine after catheterization.

B) For the cases examined with non-ionic contrast in the bladder:
   = Just prior to scanning, the patient is asked to empty the bladder by voiding.
   = CT examination included unenhanced scanning covering the entire urinary tract.
   = Intravenous injection of 80–100 ml of water-soluble non-ionic contrast medium into an antecubital vein by a power injector at a dose of 2 ml/kg of body weight at a rate of 3 ml/s.
   = Contrast-enhanced scanning covering the abdomen and pelvis at a scan delay of 60–90 s.

= After the first two scans were obtained, each patient waited in another room until he or she had desire to void (60–90 min after IV injection of contrast material). Immediately before this delayed CT performance for bladder evaluation, all patients were asked to alternately take the supine and prone positions four times on the bed beside the CT machine to obtain adequate mixing of the contrast material and urine in the bladder.

= CT scans were obtained with the patient in a supine position.

= The scanning covered the entire area of the urinary bladder.

= Virtual cystoscopy was done prior to scheduled conventional cystoscopy under general anesthesia (at the operation theater) with biopsy specimens for further evaluation.

2.2.2. Imaging process

The obtained axial CT images of the bladder were transferred to a special independent workstation running dedicated software for endoluminal navigation for review and post-processing. Standard axial, sagittal & coronal & oblique reference images are automatically obtained.

2.2.3. Bladder evaluation

To systematically indicate the location of the bladder lesion, we identified areas of the bladder wall into seven sites, including anterior, posterior, superior, inferior, Rt., Lt. sides & bladder neck. V.C. is done using a volume rendering technique. Then interactive navigation and interpretation of 3D. virtual reality imaging were performed. The camera of V.C. was located in the center of the bladder lumen and navigated seven sites in turn. The viewpoint of the observer can be manipulated through 360° in any axis and within the bladder (CT cystoscopy) & all the internal surfaces of the urinary bladder can be evaluated. When any abnormality was identified, it was fully evaluated in various projections.

2.2.4. Data analysis

The V.C. & C.C. findings for every patient were reported on separate worksheets. The number, location, morphology, size and pathological findings of the lesions were recorded. The morphology was described as either polyloid, sessile or wall thickening.

The results of V.C. were compared with those of C.C. using C.C. the gold standard with further correlation with histopathological results.

Statistical presentation & analysis of the present study were conducted using Chi-square tests by SPSS V17. The diagnostic accuracy of V.C. in detection of U.BL. masses & mucosal changes was compared with C.C. as the standard for reference through Chi square tests ($p$ value $< 0.05$ is considered significant).

NB: Extraluminal tumor extension was evaluated in our study through axial 2D. MDCT.
3. Results

Statistical data analysis of the current study was conducted on the G.I. 50 patients who were subjected to the MDCT, after air insufflation, with V.C. reconstruction then C.C. & confirmed histopathologically. Those 50 patients included; 36 males & 14 females, with age ranged from 32–78 years & mean age, 55 years as shown in Table 1.

We found that males were more affected by urinary bladder neoplasms (36/50) (72%) in comparison to the females (28%) & the 6th decade age group was the most affected one (23/50) (46%), followed by 7th decade one (14/50) (28%).

All the 50 patients of our study underwent C. cystoscopy & revealed 93 intravesical masses.

Out of those 50 patients; 32 had solitary intravesical mass (64%), 18 patients had multiple intravesical masses (36%) 6 patients had two masses, 4 patients had three masses, 4 patients had four masses, 3 patients had five masses and one patient had six masses), as shown in Table 2.

We found that TCC was rather polypoidal (30/39) (76.9%) than to sessile in (9/39) (23.1%), while the SCC was rather sessile in (43/51) (84.3%) than polypoidal (8/51) (15.7%) (Tables 3 and 4).

Out of 93 detected intravesical masses by conventional cystoscopy, CT virtual cystoscopy detected 91 lesions (91/93) (97.8%); 38 were polypoidal lesions (38/39) (97.4%) and 53 were sessile (53/54) (98.1%) as shown in Table 5.

The CT V. cystoscopy had high sensitivity in detection of intravesical lesion whether polypoidal (97.4%) or sessile ones (98.1%).

The sensitivity of axial CT after air insufflation (2D) & CT V. cystoscopy (3D) was compared to that of C. cystoscopy in consideration to the size of the mass lesion as shown in Table 6 and Figs. 1–5.

The CT V. cystoscopy had higher sensitivity in detection of intravesical mass lesions (<5 mm) (11/12) (91.6%) in comparison to that of axial CT after air insufflation (2D) (8/12) (66.67%), also in detection of mass lesion (5–10 mm), the CT

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Age &amp; sex distribution of the 50 patients of our study.</th>
</tr>
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<tbody>
<tr>
<td>Age groups (years)</td>
<td>Sex</td>
</tr>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>30–40</td>
<td>2</td>
</tr>
<tr>
<td>&gt;40–50</td>
<td>4</td>
</tr>
<tr>
<td>&gt;50–60</td>
<td>17</td>
</tr>
<tr>
<td>&gt;60–70</td>
<td>9</td>
</tr>
<tr>
<td>&gt;70</td>
<td>4</td>
</tr>
<tr>
<td>T. No.</td>
<td>36</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Distribution of 93 intravesical masses (detected by conventional cystoscopy) in 50 patients of the current study according to their multiplicity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplicity of intravesical masses</td>
<td>Number of patients</td>
</tr>
<tr>
<td>Patients with a solitary mass lesion</td>
<td>32</td>
</tr>
<tr>
<td>Patients with two mass lesions</td>
<td>6</td>
</tr>
<tr>
<td>Patients with three mass lesions</td>
<td>4</td>
</tr>
<tr>
<td>Patients with four mass lesions</td>
<td>4</td>
</tr>
<tr>
<td>Patients with five mass lesions</td>
<td>3</td>
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<tr>
<td>Patients with six mass lesions</td>
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<td>Total</td>
<td>50</td>
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</table>

<table>
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<th>Table 3</th>
<th>Histopathological classification of cystoscopic biopsy of the 50 patients of our study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Histopathology</td>
<td>No. of patients</td>
</tr>
<tr>
<td>(A) Malignant mass lesion</td>
<td></td>
</tr>
<tr>
<td>(i) Transitional cell carcinoma</td>
<td>36</td>
</tr>
<tr>
<td>(ii) Squamous cell carcinoma</td>
<td>11</td>
</tr>
<tr>
<td>(iii) Adenocarcinoma</td>
<td>1</td>
</tr>
<tr>
<td>(B) Benign mass lesion</td>
<td></td>
</tr>
<tr>
<td>(i) Polypoidal cystitis</td>
<td>1</td>
</tr>
<tr>
<td>(ii) Nephrogenic adenoma</td>
<td>1</td>
</tr>
<tr>
<td>Total No.</td>
<td>50</td>
</tr>
</tbody>
</table>
MDCT VC in urinary bladder carcinoma

V. cystoscopy had higher sensitivity (45/46) (97.8%) in comparison to that of axial CT after air insufflation (2D) (41/46) (89%), consequently the total sensitivity of V.C. was higher (91/93) (97.8%) in comparison to that of axial CT (2D) (84/93) (90.3%).

The sensitivity of detection of the lesions > 10 mm was 100% at both axial CT after air insufflation (2D) and CT V.C.

On V.C. there were two false negative results; the first lesion was polypoidal (3 mm) at the left lateral wall beside the ureteric orifice, while the second lesion was sessile (6 mm) in a trabeculated bladder due to prostatic hypertrophy.

CT scanning was well tolerated by all patients, and no complications occurred.

Images were of good quality in 49 patients (98%), except for one examination, the images were suboptimal due to restricted bladder capacity by infiltrating tumor.

In G.II.a.: the 2 patients who had urethral stricture & not amenable to catheterization & air insufflation were subjected to intravenous contrast administration & revealed; 5 lesions detected by C.C. & CT V.C.

In G.II.b.: the 3 patients who had narrow neck diverticulae; C.C. could not evaluate interior part of the diverticule while V.C. demonstrated them clearly and detected intradiverticular tumors, one of the cases was accompanied by a cystocele that could not be detected by C.C. Our results were confirmed histopathologically.

Mucosal thickening and trabeculation were detected in 5 patients by C.C. & V.C. equally. In addition to morphological changes, C.C. noted acuteness (hyperemia & exudate) on top of chronicity in 7 patients with cystitis & leukoplakia in 4 patients, while could not be detected on V.C. as shown in Table 7.

Occasionally, in three of the fifty patients in our study, air refluxed into the ureter and so, we obtained CT virtual images of the ureteric lumen.

Computed tomography axial images showed lower ureteric extension from bladder tumors in 2 cases which could not be evaluated by C.C. The intraluminal lower ureteric extension was evident at CT virtual images.

Transverse images demonstrated extravescical extension into the adjacent pelvic organs in 5 cases (three to the uterus and two to the prostate) was proven at histopathology.

We found two pseudolesions that appeared on virtual cystoscopy. One of them was a phlebolith and the other was an enlarged median lobe of the prostate, both were correctly identified on combined axial CT and V.C. Areas of bladder wall thickening were more readily appreciated on transverse images.

Table 5 - Sensitivity of CT V.C. in comparison to C.C. in relation to the lesion morphology.

<table>
<thead>
<tr>
<th>Morphology</th>
<th>No.</th>
<th>C.C. No. of detectable lesion by</th>
<th>Sensitivity (%)</th>
<th>CT V.C. No. of detectable lesion by</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypoid</td>
<td>39</td>
<td>39</td>
<td>100</td>
<td>38</td>
<td>97.4</td>
</tr>
<tr>
<td>Sessile</td>
<td>54</td>
<td>54</td>
<td>100</td>
<td>53</td>
<td>98.1</td>
</tr>
<tr>
<td>Total No.</td>
<td>93</td>
<td>93</td>
<td>100</td>
<td>91</td>
<td>97.8</td>
</tr>
</tbody>
</table>

P-value 0.981
Sign. NS (non-sign)

N.B. Non-sign. > 0.05, Sign. < 0.05. High, sign. < 0.001.

4. Discussion

Interestingly, the most common histopathologic type of U.BL. cancer in Egypt has been SCC contrary to the leading etiology of smoking and occupational exposures in Western countries. Urinary Schistosomiasis has been the most important risk factor in Egypt for bladder cancer in Egypt (3).

Reduction in Schistosomal infection and increase in cigarette smoking and chemical exposure related to occupational hazards have resulted in significantly changing pattern of bladder cancer in Egypt & TCC has become the most frequent form (3). In our study of 50 patients with U.BL. masses; 48 patients were having malignant masses {36 were TCC (75%) & 11 were SCC. (22.9%) & 1 was adenocarcinoma (2%)}. C.C. remains the mainstay for diagnosis, proper evaluation and follow up of bladder masses. Once the diagnosis of bladder tumor has been established U/S, CT, and MRI are performed for staging (9).

Recently, three dimensional computer rendering techniques with rapid image acquisition have led to the development of virtual − reality imaging which allows interactive intraluminal navigation through a hollow viscus, simulating conventional cystoscopy. This technique of V. endoscopy has been applied to many organs including the colon, bronchus, stomach & U.BL. (4,10). V. endoscopy has been the most widely applied to the imaging of the colon (virtual colonoscopy) (11). Recent advances in computer technology e.g. spiral and multidetector CT & M.R.I. imaging with rapid image acquisition and 3D. rendering have led to the development of V. cystoscopy. Vining et al. were the first to apply this technique in detection of bladder cancer (12). After several studies including CT or MRI. V. endoscopy of the bladder has been established (13,14).

As C.C. still plays the key role in the diagnosis of bladder tumor, V. cystoscopy may be less invasive alternative in diagnostic work up (15). In the current study we tried to demonstrate that CT V.C. is a feasible technique for detection of bladder masses and to compare between it & C.C.

Meticulous bladder preparation is necessary for an accurate interpretation. Besides the requirement to distend the bladder properly, it is important to increase the difference in CT attenuation between the bladder wall and the lumen in order to optimize the V.C. independently of type of contrast used (16). There are two different principles for distending the bladder and increasing the intraluminal contrast retrograde via urethral catheter with insufflation of air or CO₂ or using the excretory function of the urinary system to fill the bladder with I.V. contrast material (17).
The superiority of air insufflation was due to optimal bladder distension achieved by this method. Air-filled bladder provides optimal attenuation gradient between walls and lumen leading to difference greater than 1000 H.U., thus making virtual reconstruction, less prone to artifact. A drawback of air-filled bladder method is the need for a bladder catheter, so it is not completely non-invasive (11), also V.C. with air filled bladder requires the patient to be scanned twice, in the supine and prone positions to be sure that air interfaces with each segment of bladder (18). In our current study, we used room air achieving adequate distension, however in two patients of our study, catheterization was not amenable because of urethral stricture & I.V. non-ionic contrast media was utilized for bladder opacification.

V.C is a post processing technique performed on 3D workstation which allows the creation of endoluminal views on the bases of high resolution 3D datasets. V.C. has three components (image acquisition, processing and analysis) (19). The only datasets that can be used for VC are those acquired as continual image acquisition during one breath hold period for reconstruction of a high spatial resolution image that is nearly equal in all three dimensions & with very high contrast between the hollow organ lumen and adjacent structure for optimal segmentation of the examined organ (20).

There are several possibilities for acquiring such datasets, most commonly the MDCT scanners. Panebianco and his colleagues pointed out that the use of 64 row detector CT technology improves the spatial resolution, so excellent sensitivity can be obtained for very small lesions (21). In the current study CT V. cystoscopy was performed with scanning parameter similar to that of Panebianco and his colleagues, the slice thickness was to some extent higher (1 mm). An A.P. scout view of the pelvis is first obtained in supine position to plan for helical CT scan, followed by helical CT scanning of distended U.BL., during one breath hold to prevent breathing artifacts (15).

CT V. allows accurate measurement of tumor dimensions & can be used to monitor treatment response in patient with non-resectable tumor (15). In the current study the sensitivity of V.C. in detection of vesical mass was higher than that of 2D axial CT & the sensitivity of detection of vesical masses increased by increase in the size of the masses on either techniques (i.e sensitivity of V.C. in (<5 mm) masses was (11/12) (91.6%) & increased to (45/46) (97.8%) in (5–10 mm) masses, while on axial CT sensitivity was (8/12) (66.7%) in (<5 mm masses) & increased to (41/46) (89.1%) in (5–10 mm) masses. Axial images are essential for the evaluation of extraluminal component of the tumor and the presence of nodal metastases (16). In our study we found that out of 50 patients with vesical masses, 5 patients were having pelvic extraluminal extension detected by 2D axial CT after air insufflation which proven later histopathologically.

Kim et al. stated that V.C. is more accurate than multiplaner reconstruction and source CT image for detection of vesical masses (22). Results of most carried out studies indicated that V.C. allows the accurate assessment of localization and morphology of bladder masses. (21). These results were in good agreement with those of our study where out of 93 vesical masses detected by C.C., CT V.C. detected 91 masses (38 were polypoidal (38/39) (97.4%) and 53 were sessile (98.1%)).

Panebianco and his colleagues (20) found that the sensitivity of V.C. of air-filled bladder in detection of 24 bladder
masses (<5 mm) was (93%) & in detection of 16 bladder masses (5–9 mm) was (100%). These results were in good agreement with those of our study where CT V. C. sensitivity of 12 bladder masses (<5 mm) was 91.8% & in detection of 46 bladder masses (5–10 mm) was (97.8%), however in our study two vesical lesions could not be detected on V.C., the 1st one

Fig. 1  A male patient aged 57 y. with multiple intravesical masses (GIII. papillary transitional cell carcinoma). (a) Axial, (b) coronal & (c) sagittal MDCT pelvis after air insufflation revealed; Rt., Lt. lat. & post. vesical wall growths + Lt. posterolat. vesical diverticulm with intradiverticular growth. (d, e) virtual CT cystoscopy revealed; multiple variable sized masses involving the Rt. & Lt. lat. & post. vesical wall, with visualized diverticular opening (arrowed) & intradiverticular mass (f). (g) Conventional cystoscopy revealed; multiple variable sized intravesical masses involving the Rt. & Lt. lat. & post. vesical wall.
A female patient aged 67 y. presented with loin pain 1 year ago & hematuria 1 month ago. (T.C.C.GIII. of U.BL. infiltrating intramural part of the Rt. ureter). (a–c) axial & (d) sagittal MDCI of the pelvis & abdomen after I.V. contrast revealed; Rt. sided intravesical mass (arrowed) involving the intramural part of the ipsilat. ureter with 2ry marked hydronephrotic changes, also Rt. seminal vesicle is infiltrated. The lt. ureter is mildly dilated (arrowed) at its distal part. (e) 3 D. volume rendering CT of the Rt. kidney & ureter & U.BL. (posterior view) revealed; intravesical mass (blue arrow) extending into pelvic segment of the Rt. ureter, with 2ry marked renal parenchym. atrophic changes. (f) 3 D volume rendering CT of the Lt. kidney, ureter & U.BL. (posterior view) revealed; stricture of the lower end of the Lt. ureter with mild proximal ipsil. ureteric dilatation. (g) V.C. revealed; a solitary sessile fungating intravesical mass with sharply defined margin. (h) Conventional cystoscopy revealed; a large intravesical fungating mass in the trigone of U. Bl. & more to the Rt. side.
was polypoidal lesion (3 mm) beside the Lt. ureteric orifice while the 2nd one was sessile lesion (6 mm) in a trabeculated U.BL due to prostatic hypertrophy.

In addition to bladder mass detection V.C. had detected internal anatomy of U.BL. & vesical mural trabeculations adequately (20). Stenz et al. (23) described the usefulness of V.C. in visualization of any intraluminal changes as cystocele, diverticulosis, voiding problem, and understanding of the post-operative orthotopic intestinal bladder substitution. However still there are many drawbacks of VC including its inability to mucosal color changes such as leukoplakia and carcinoma in situ that are detected only by C.C. as reported by Henz-Peer et al., and Song et al. (19,21). In addition calcifications associated with masses were non-visualized on the virtual images due to threshold selection optimized to depict soft tissue abnormalities. Another important factor is that V.C. alone cannot make sure the origin of mass. Song et al. (21) reported that extravasal pseudolesion that simulated intraluminal masses on virtual views was then correctly identified on axial CT images. So many authors agree that transverse images together with V.C. are complementary for lesion detection and characterization & to obtain optimum results (21,24).

In the present study; C. cystoscopy detected 4 cases with leukoplakia and 7 cases with hyperemia, whereas V.C. could not detect any of these color changes.

The ability of V.C. to navigate into narrow mouthed diverticulae as mentioned by Panebianco et al. (25) although uncommon diverticular carcinoma is difficult to be detected on C. In our study of GIIb. on three patients, the C.C. could not evaluate interior part of the diverticulum, whereas V.C. demonstrated it clearly & detected intradiverticular tumors confirmed by histopathology.

Fig. 3  A female patient aged 67 y, coming for follow up after TURBT (T.C.C.). (a) (axial), (b) (coronal) & (c-e) (sagittal) MDCT of the pelvis after air-insufflation revealed; a small nodular growth (7 mm) noted at the Rt. Inferolateral wall of U.BL., with so fine calcific foci on its surface in addition to accidental air refluxing into the Lt. ureter (arrow). (f & g) V.C. revealed; intravesical inferolateral polypoidal growth, with an irregular surface & sharply defined margin & distended Lt. ureter with air (g). (h) C.C. revealed; Rt. inferolateral intravesical soft tissue mass with calcific foci on its surface.
Many factors can affect the accuracy of CT V. such as a modality for detection of U.B.L. masses, first of all, the rapidly advancing computer system, also cooperation of the patients during catheterization, the good distensibility of U.B.L., the amount of residual urine, and also the experience of the Radiologist with a gazing eye and a fine hand performing it. In our study of 50 patients, CT examination was well tolerated with good quality image in 49 patients (98%), except in one examination the image was suboptimal because of restricted bladder capacity by infiltrating tumor (20).

The authors propose that V.C. may be alternative to C.C. in selected cases. It could be useful when C.C. is difficult to be performed or contraindicated, and in patients who are at risk of complications or in young patients (pediatric age group) (20). It can serve as a complementary examination for C.C. in follow up of patients with bladder cancer who are undergoing treatment.
A male patient aged 65 y presented with recurrent attacks of hematuria (papillary T.C.C. GIII.). (a) (axial in prone position), (b) (coronal) & (c) (sagittal) MDCT pelvis after air insufflation revealed; an intravesical nodular soft tissue mass arising from the Rt. Posterolateral wall nearby the vesical neck and Rt. ureteric orifice. (d, e) V.C. revealed; a large intravesical mass (red arrow) & two subtle lesions (black arrow) & Nelaton catheter (yellow arrow). (f & g) C. cystoscopy revealed polypoidal mass (f) & subtle flat lesions (g).

<table>
<thead>
<tr>
<th>Mucosal changes</th>
<th>No. of detectable cases by</th>
<th>C. cystoscopy</th>
<th>Sensitivity (%)</th>
<th>V. cystoscopy</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucosal thickening</td>
<td>5</td>
<td>100</td>
<td>5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Fine nodularities/coarseness</td>
<td>9</td>
<td>100</td>
<td>9</td>
<td>100</td>
<td></td>
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<tr>
<td>Leukoplakia</td>
<td>4</td>
<td>100</td>
<td>–</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hyperemia</td>
<td>7</td>
<td>100</td>
<td>–</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total No.</td>
<td>25</td>
<td>100</td>
<td>14</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>(P)-value</td>
<td>0.035*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>S (significant)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N.B. Non-sign. > 0.05. *Sign. < 0.05. High sign. < 0.001.
5. Conclusions

U.BL. carcinoma is the most common malignant neoplasm of U.T., accounting for 90% of cancer cases. C.C. represents the gold standard for diagnosis & local management of U.BL. carcinoma, not only because of its high sensitivity in detecting lesions and subtle alteration of the mucosal changes but also the possibilities of performing resections or biopsies in real-time.

The results of V.C. & C.C. were comparable in detection, localization & morphometry description of the bladder masses. V.C. has several advantages over C.C. where it is minimally invasive, allowing intraluminal viewing of U.BL. from any angle and bypassing any obstruction if present. It allows also access to some areas which may be sometimes inaccessible by C.C. & its ability to accurately record tumor maximum dimension & volume without magnification or distortion.

CT V.C. has still some limitations, it is unable to depict flat lesions or mucosal color changes, it lacks the ability to provide tissue for histopathology & to identify the origin & nature of bladder mass, so the complementary interpretation of V.C. & axial CT information is essential, allowing V.C. to obtain adequate results comparable to those of C.C.

V.C. may be an alternative or a complementary examination where C.C. is difficult to be performed or contraindicated. CT V.C. is not a competitive technique to C.C. of U.BL., on the contrary, it has been proved also to be a useful complementary examination performed between repeated C.C. examinations in patients with bladder cancer who are undergoing treatments. It is easily acceptable and could be performed when the patient refuse to undergo C.C.

Conflict of interest

We have no conflict of interest to declare.

References