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Recurrent bladder tumors after transurethral resection: Diagnostic yield of MDCT-virtual cystoscopy

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ABSTRACT

Purpose: To evaluate the diagnostic efficacy of computed tomography-virtual cystoscopy in the depiction of recurrent bladder tumors after transuretehral resection (TUR) and compare its results with those of standard invasive conventional cystoscopy.
Patients and methods: From December 2013 to June 2016, 33 patients (26 males, 7 females), with mean age 62.76 ± 10.45 years, who were coming for routine follow up following transurethral resection of malignant bladder masses or complaining of recurrent postoperative hematuria were included in the study. Computed tomography virtual cystoscopy (CT-VC) was performed for all patients followed by conventional cystoscopy (CC) within maximum three days.
The results of both studies were carefully analysed and compared for presence of lesions, their size, location, morphology and signs of local invasion. Additional information obtained from CT source images included features of extravesical extension, presence of locoregional lymph nodes or distant metastases.
Results: The sensitivity, specificity, PPV and NPV of CT-VC for the detection and characterization of recurrent bladder lesions were 82.8%, 81.8%, 93.5% and 60% respectively. The diagnostic results varied significantly ($P = 0.03$ and 0.037) between CC and axial supine and prone MDCT images and was not significant ($P = 0.99$) between CC and CT-V.
Conclusions: CT-VC is a minimally invasive method to detect recurrent bladder tumors after transurethral resection and is advised as a routine follow-up study.

1. Introduction

Bladder cancer is the second most common genitourinary malignancy, accounting for 7% of all cancers. It ranks as the fourth common cancer among men and the eighth among women [1–3] and causes 15.6% of cancer-related deaths among Egyptian males [4].

Tumor recurrence is one of the most troublesome features of urinary bladder malignancies and is typically associated with advanced stages and high grades [5–7]. About 75–80% of all bladder cancer cases are diagnosed as non-muscle-invasive bladder cancer [2–32]. The estimated recurrence rate of those tumors limited to the mucosa is 50 to 70% [7]. Transurethral resection (TUR) using a wire loop is the standard treatment of bladder tumors, however it has been postulated that about 60% of treated patients will develop a recurrence within a 5 years [14,15]. Early second resection has been shown to decrease recurrence rate. Therefore, close monitoring and follow up of the postoperative patients at regular intervals is mandatory to reduce mortality rates from bladder cancer [14].

Postsurgical surveillance of bladder pathology after TUR is traditionally done by interval cystoscopy [14], especially for superficial tumors for which biopsy and resection procedures can be performed in the same setting [7]. However, conventional cystoscopy (CC) has several limitations: it is an expensive, invasive and lengthy procedure, requiring sedation of the patient. It is limited in the evaluation of bladder neck and narrow neck diverticular tumors especially in males. It is also associated with high risk of urethral strictures as a complication of urinary sepsis and urethral injury [8].

Abbreviations: CC, conventional cystoscopy; 3D, three-dimensional; MDCT, multidetector computed tomography; CT-VC, , computed tomographyvirtual cystoscopy; MPR, multiplanar reconstruction; TUR, transurethral resection.

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With computer assisted rapid image acquisition and three-dimensional image reconstruction by commercially available software, virtual reality imaging has been developed which allows interactive intraluminal navigation through any hollow viscus, imitating conventional endoscopy. This can be applied to many organs, including the stomach, colon, bronchus, and bladder [3–8]. The urinary bladder may possibly be an ideal intra-abdominal organ for computed tomography virtual cystoscopy (CT-VC) because of its simple luminal morphology, relatively small volume, and absence of involuntary peristalsis [9]. CT-VC provides many advantages, as it offers the precise localization of a lesion due to its wide field of view and ability to navigate the bladder mucosal surface in various projections. It also allows the detection of extravesical extension and distant pathologies [10]. Despite the fact that no biopsy can be taken from the bladder mass, and that the sensitivity of VC for detecting small masses (<5 mm) is lower, the minimally invasive nature and patient comfort are major advantages of CT-VC in comparison to conventional cystoscopy [3–12].

Thus the main aim of the present study was to analyze the diagnostic potential and the role of CT-VC for detecting and evaluating recurrent bladder cancer, compared to standard CC.

2. Patients and methods

2.1. Patients

33 patients with history of transuretehral resection of urothelial cancer who serially presented from December 2013 to June 2016 at Ain Shams University hospitals and private centers and were admitted for follow-up check cystoscopy were included in the study. The age ranged from 32 to 77 years, 26 were males, and 7 were females. An informed consent was taken from all patients and ethics committee approval was obtained. A urine analysis/culture/cytology for malignant cells, renal function tests, and ultrasonography of kidney, ureters, and bladder (KUB) region, were performed for all patients. CT examinations were undertaken with a 16 slice multidetector computed tomography (MDCT) scanner (Bright Speed 16; GE Medical Systems). Conventional cystoscopy was performed for all patients, within maximum three days after the MDCT exam, this time gap should not change the appearance of the lesions or provide enough time for developing denovo lesions.

2.2. Technique

Patients underwent either contrast filled technique (16 patients) or air filled technique (17 patients). In the contrast filled technique, the patient was asked to void before the examination to avoid fluid-fluid layering and to ensure better image quality, then a dose of 50 ml non-ionic low osmolar contrast media was injected intravenously. For adequate mixing of contrast medium with urine in the bladder, the patient was asked to alternate taking supine and prone positions four times before starting the procedure. Scanning was performed in the parenchymal phase of enhancement (30–50 s p.i.) in order to evaluate the upper and lower tract enhancing lesions, extravesical extensions, lymph nodes, and or distant metastasis and then in the delayed excretory phase (at least 30 min, better 60 min p.i.) with the bladder filled with contrast.

In the air filled technique residual urine was drained by placing a 12-French Foley's catheter into the urinary bladder, and the bladder was then insufflated with 200–450 ml of room air using 60 cc syringe and clamp, according to the bladder capacity and tolerance. In few cases, the catheter was withdrawn to the distal penile urethra so that the urethra may also be visualized at the time of virtual cystoscopy. A scout view was initially obtained with the patient in the supine position to confirm adequate bladder distention. Subsequently, axial MDCT scan of the pelvis was performed with a minimal field of view according to the following parameters: 120 kV; detector collimation, 16×0.75 mm; mAs, 140–160; matrix, 512×512; gantry rotation speed, 0.5 s; slice width 1–2 mm; reconstruction interval, 0 mm; and reconstruction thickness, 1.2 mm. The procedure was repeated with the patient in prone position using the same CT parameters. Abdominopelvic axial scanning after intravenous injection of nonionic contrast medium (100 mL) was performed at the portal phase (60 s) in case of detectable lesions for extravesical extension and other possible pathologies.

The data are then transferred to a workstation for multiplanar reconstruction (MPR) images and 3-D virtual reconstruction and image analysis. Initially, segmentation of axial images is performed, and bladder wall irregularities, focal or diffuse thickness, and polypoid or sessile lesions were reported, together with extravesical involvement. After that, three dimensional (3D) perspective volume-rendering algorithms are used to generate intraluminal views of the bladder. Using the multiplanar reformation (MPR) from the source images, the central observation point was defined in the middle of the bladder. The camera of the virtual cystoscopy was placed in the center of the bladder and thereafter advanced to the six segments of the bladder wall; the superior, inferior, anterior, posterior, right and left lateral walls.

Two radiologists, unaware of the findings of conventional cystoscopy, independently interpreted the images, and any discrepant readings were resolved by consensus. The number, size, location, and morphology of the lesions were evaluated. The lesions were described as polypoid, sessile or areas of wall thickening. A lesion was characterized as focal wall thickening when there was elevation of the bladder wall without a discrete mass. A discrete polypoidal lesion is described as being taller than wider, while a sessile mass was defined as a lesion that was wider at the base. Extravesical extension, involvement of locoregional lymph nodes, or, any, abdominal metastases were assessed.

Subsequently, each of the patients underwent conventional cystoscopy (CC) within maximum three days. The urologists, who were not preminded with virtual cystoscopic findings, performed cystoscopic examinations using rigid wide angle telescopes. They recorded, the number, location, and morphology of the bladder lesions by drawing or video-recording. CC findings were used as reference standard to evaluate the sensitivity, specificity, positive predictive value, and negative predictive value of CTVC for detection and characterization of bladder tumors. The histological diagnoses of biopsies taken during CC were then correlated with these findings. Data were checked, coded, entered and analysed using commercially available software.

2.3. Statistics

Using the results of CC as a reference, statistical cross tables were created after determination of the true positive and true negative values. The sensitivity, specificity, PPV and NPV of CT-VC for the detection and characterization of recurrent bladder lesions were measured. The sensitivity of MPR for detection of small lesions and for localization of lesions were analysed and compared with those of axial supine and prone films. The Liddell's exact test was used to test the statistical significance of differences amongst the urinary bladder findings of axial CT supine images, axial CT prone images, MPR images and CT-VC, respectively, and with the findings of CC, with $P < 0.05$ considered to indicate significant differences (see Fig. 1).

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