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# The role of 3-dimensional sonography and virtual sonographic cystscopy in detection of bladder tumors

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Virtual cystoscopy;
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**Abstract**
*Introduction:* Bladder cancer is the second most common genitourinary malignancy. Recent technological advances have led to the development of virtual endoluminal internal views similar to those obtained with conventional endoscopy (virtual cystoscopy).
*Objectives:* To evaluate the potential value of virtual cystoscopy in the detection and follow up of bladder tumors.
*Patients and methods:* A total of 50 patients from Ain Shams University Hospital were studied between August 2012 and April 2014 at Ain Shams' Radiology Department and Sonoscan Radiology Center. All patients underwent 2D-US, 3D virtual sonographic cystoscopy and conventional cystoscopy, with results compared for sensitivity and specificity in correlation with the site, size and shape of the tumor.
*Results:* 3D virtual cystoscopy showed a sensitivity of 96.5%; while its specificity in identifying lesions was 85.7%; positive predictive values were 96.5%; negative predictive value were 85.7%. The sensitivity of the 2D ultrasound was 77.2%; while its specificity in identifying lesions was 57.1%; positive predictive values came at 88%; negative predictive value were 38.1%. Calculations were made taking into consideration the conventional cystoscopy "gold standard".
*Conclusion:* Additional to lower costs and no radiation exposure, 3D sonography appears comparable to the use of CT scans and MRI in providing virtual cystoscopy in investigating bladder cancer. Virtual sonographic cystoscopy may therefore be a useful alternative for screening and follow up of tumors, particularly if conventional cystoscopy cannot be performed. However, 3D sonography cannot replace pathological

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staging, and there is still a need to further improve this technology for enhanced assessment of mucosal abnormalities.



## Introduction

Bladder cancer is the 9th most common form of cancer worldwide; with 13.1 cases per 100,000, Egypt ranks in 10th position by country in terms of bladder cancer incidence [1].

The current evaluator method for initial diagnosis traditionally involves IVU with two-dimensional ultrasonography (2D-US), CT, MRI and cystoscopy with eventual biopsy, of which the latter is an invasive and relatively expensive procedure. Trans-abdominal 2D-US is often used for examining patients when a bladder tumor is suspected. Although the majority of exophytic tumors can be detected, small papillary tumors, flat 'lawn-like' tumors and those on the dome of the bladder, in particular, present low detectablility or cannot be differentiated from benign lesions [2,3].

The sensitivity of US in detecting bladder tumors depends on operator experience, and is variably reported to range between 26% and over 80% [4,5]. However, this rate is much lower in patients with tumors smaller than 5 mm or for tumors located on the bladder dome or anterior wall [5].

Recent advances in computer technology and display techniques (including spiral and multi-detector CT imaging and MRI with rapid image acquisition and 3-dimensional [3D] rendering) have led to the development of virtual endoluminal views of hollow organs, similar to those obtained with conventional endoscopy. Virtual cystoscopy performed via computed tomography or magnetic resonance imaging has been developed with promising results [6–9]. These techniques appear more sensitive than US, despite their being significantly more time consuming, expensive, and frequently inaccessible for clinicians (Fig. 1).

Three-dimensional ultrasound is now an established imaging tool in several specialties, and is available as part of most medium and upscale equipment. In urology, it has been used in planning and guiding treatment for prostate cancer [10], to accurately measure bladder volume [11], and in imaging the urethral sphincter in pelvic floor disorders [12]. Vining et al. [13] were the first to apply this technique in the detection of bladder cancers, after several studies, including CT or MR virtual endoscopy of the bladder, were published [14–19].

Three-dimension US imaging has recently become a widely available feature as part of many ultrasound machines. This technology permits the acquisition and storage of a dataset selected from a specific region of interest, which can be further analyzed, either by multiplanar display, surface rendering, or volume calculation. As there is a considerable contrast gradient between the bladder lumen and its wall, the surface rendering algorithm can usually display, with sufficient detail, the surface of the bladder, revealing a cystoscopy-like image, enhancing the characterisation of bladder wall abnormalities [20].

In our study we aimed to evaluate the potential value of virtual cystoscopy in the detection and follow up of bladder tumors (Fig. 2).

## Patients and methods

A total of 50 patients fitting the inclusion criteria were selected from the Urology Clinic at the Ain Shams University Hospital at El-Demerdash, and were prospectively enrolled in our study in the period between August 2012 and April 2014.

Inclusion criteria for patients taking part included: presentation of total gross painless hematuria without a history of trauma or evidence of urinary tract injury or infection; suspicious lesions or inconclusive readings by 2D ultrasonography and scheduled for cystoscopy; patients scheduled for follow up cystoscopy after previous superficial bladder tumor resection. Patients presenting with hematuria due to systemic etiology, patients who were diagnosed with CIS from previous cystoscopy, patients with kidney disease, or calculi causing the hematuria and patients unfit for surgical intervention were excluded from the study (Table 1).

All patients underwent trans-abdominal 2D US focusing on the bladder and kidneys. Patients were subsequently scheduled for a 3D US examination the following day and conventional cystoscopy with a rigid cystoscope within 14 days. Written informed consent was obtained from each patient, and the study was approved by the Ethics Committee at Ain Shams University. Sonographic examinations were undertaken through a single experienced radiologist using a SonoAce X8 system (MEDISON Co.,Ltd.), with a 4–7 MHz volume trans-abdominal transducer used to create images. The radiologist was unaware of the 2D US results.

### *Examination protocol*

Approximately 1 h before the US examination, 500 ml of water was orally given to each patient. The examination was performed with the bladder filled up to 350 ml, or up to each patient's tolerance.

### *2D ultrasonography*

An initial routine gray-scale sonography of the bladder was performed. The device parameter settings were optimised to ensure high-quality 2D images, with the size, location, morphology and number of the tumors recorded.

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