Virtual cystoscopy: Reality in imaging of bladder tuberculosis

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ABSTRACT

We present a case of urinary tuberculosis investigated initially by ultrasound and multidetector computed tomography (MDCT). The MDCT-derived volumetric data were used to generate virtual cystoscopy (VC) images, which revealed a bladder ulcer. The presence of this ulcer was confirmed by conventional cystoscopy-guided biopsy and there was good agreement regarding various features of the ulcer, such as the site, size and shape, as detected by virtual and conventional cystoscopies. VC, a result of simple postprocessing of preacquired MDCT data, proved valuable in the characterization of the bladder lesion in conjunction with CT and ultrasound images. Although a larger study is warranted, in our case these en face VC representations of the ulcer served as useful precursors to conventional cystoscopic biopsy.

KEY WORDS: Bladder tuberculosis, conventional cystoscopy, virtual cystoscopy

Conventional cystoscopy, an invasive investigation, plays a key role in the diagnosis of urinary bladder diseases. Virtual cystoscopy (VC), derived from postprocessing of rapidly acquired multidetector computed tomography (MDCT) has been used for identification and characterization of bladder masses.[1–4] The purpose of this case report is to essentially highlight the use and advantages of VC in tuberculous bladder lesions, such as ulcers, as an adjunct to basic imaging and as a tool that precedes conventional cystoscopic biopsies.

Case History

A 42-year-old female, symptomatic for the past 2 years, presented with complaints of dysuria, urinary urgency, frequency, and painless hematuria that was accompanied by intermittent episodes of passage of blood clots and clot colic. Her complaints included a continuous, dull, right flank pain, low-grade fever, and recurrent urinary tract infections refractory to antibiotics. Recent salient laboratory investigations revealed presence of anemia, leukocytosis, increased erythrocyte sedimentation rate (80 mm at the end of 1 h), and serum creatinine level of 1.8 mg/dl. Urinary polymerase chain reaction was positive for tuberculosis (TB). However, urine was negative both for acid fast bacilli and culture.

Chest radiographs were normal. Ultrasound (Figure 1) of the urinary tract revealed bilateral mild-moderate hydronephrosis, severe hydroureteronephrosis of the left kidney, and a small capacity bladder with a distinct solitary ulcer with undermined edges. MDCT of the abdomen was performed (Figure 2; Siemens Volume Zoom, Forchheim, Germany). The scanner employed a 0.5-s gantry rotation speed, eight detector rows, and four image acquisition systems. Plain, contrast-enhanced [with 120-ml nonionic iodinated contrast intravenously (IV, iopromide, Ultravist 370, Schering)], and delayed scans were obtained at 120 kV/250 mA. Collimation of 5 mm was used, except for the plain and delayed scans of the bladder region, where 1.25-mm collimation was used. Effective dose of the entire examination was 14.4 mSv. Prior to the delayed scan, alternate supine/prone patient positions were performed five times to facilitate adequate contrast-urine mixing in the bladder. CT, in addition to confirming the ultrasound findings, revealed that the right ureter had a stricture in its lower third segment and the left kidney was nonfunctioning. The MDCT-derived volume dataset (of the contrast-filled bladder on delayed scan) was used to generate VC images (Figure 3) on a workstation (3D Virtuoso, Silicon Graphics, Mountain View, CA) that confirmed the right posterior wall ulcer, superior to the trigone, and the right ureteric orifice. A diethyl triamine penta-acetic acid (DTPA) renogram confirmed left renal dysfunction.

A conventional cystoscopic biopsy (Figure 4; Karl Storz 30° cystoscope with Storz Endocamera, passed through a 21-French
Figure 1: Ultrasound images depicting moderate right-sided hydronephrosis (arrow, upper frame) and an ulcer in the right posterior wall on transverse scan of the urinary bladder (arrow, lower frame). Note that the ulcer has a somewhat irregular, ragged, undermined edge.

Figure 2: Abdominal (upper frames) and pelvic (lower frames) CT. A functioning moderately dilated right pelvicalyceal system and pelvic ureter (white arrow) result from a terminal ureteric stricture. Notice the severely dilated dysfunctional left-sided system (end-stage kidney) and bladder ulcer (black arrows).

rigid sheath) was obtained from the solitary ulcer edge. Histopathological examination (Figure 5) demonstrated the presence of multiple caseating granulomas and Langhans giant cells. A left-sided total nephrectomy was subsequently performed, which revealed tuberculosis.

**Discussion**

Persistent cystitis refractory to antibiotics and presence of pus and red cells in the urine without bacteria on routine culture should arouse suspicion of urinary TB, particularly in young adults. Mycobacteria enter the urine from the pelvicalyceal

Figure 3: VC. En face view of the triangular ulcer (arrows) depicting an irregular outline, ragged margins, and necrotic appearance. “Undermined” edges cannot be discerned. An “orientation cube” in the lower right-hand corner localizes the ulcer to the right posterior wall of the bladder.

Figure 4: A still from the conventional cystoscopy movie file demonstrates the triangular ulcer (arrows along the sides of “triangle,” as in Figure 3). However, the ragged margins or undermined edges are not clearly discernable.

Figure 5: Photomicrograph (H&E; scanning view, upper frame and 100x, lower frame) of the biopsy specimen showing multiple coalescent granulomas with widespread caseous necrosis and a Langhans giant cell (arrow).
Ultrasonound depicts bladder-wall thickening, contraction, vesicoureteric reflux, calcifications, and ulcerations.\[5\] In our case, ultrasound and CT, by virtue of their cross-sectional capability, depicted a side-on view of a typical tuberculous ulcer, with irregular, ragged, and undermined edges. CT is useful, but without adequate bladder distension and thin-slice scanning, it has low sensitivity for detection of small bladder lesions.\[6\] MDCT circumvents these limitations. MDCT and VC are proven tools for the detection and evaluation of bladder tumors.\[1–4\] CT data acquisition protocols used to generate VC employ either air or contrast material.\[1–4\] IV contrast-mediated bladder filling is easier, convenient, and less invasive than air which involves catheterization and doubled radiation doses.\[6,7\] VC can be generated from routine contrast-enhanced CT, and the entire urinary tract imaged with one comprehensive examination. We employed a volume-rendering algorithm after scanning the contrast-laden bladder for generation of VC images, which is superior to surface rendering because it retains raw data and provides better mucosal detail.\[6\]

VC has the potential to localize and characterize lesions in a manner similar to conventional cystoscopy. As it provides an en face view of lesions, surgeons can proceed with conventional cystoscopy with a mental image of the lesion, when a cystoscopic biopsy or follow-up is contemplated.\[6\] It requires fewer steps for patient preparation, is inexpensive, and patient compliance is not an issue, which are the basic attributes of a screening test. In conjunction with axial and multiplanar images, both endoluminal and exoluminal information are gathered. Unlike ultrasound and CT, the endoluminal perspective helps us obtain an en face view of the ulcer. A VC study is rapidly and easily generated (and can be done while the patient is in the scanner) as the bladder has a simple luminal anatomy, small volume, and no involuntary peristalsis.\[6\] Other potential indications are as follows: patients who decline invasive diagnostic tests, unfit patients (distal urinary obstruction, active hematuria, and bladder substitutions), and early postoperative period.\[3,4\]

However, at the time of writing, VC is unable to depict small (<5 mm), flat lesions that conventional cystoscopy can depict as subtle, mucosal alterations. Benign (inflammatory/tuberculous/fibrous) and malignant mucosal thickening may be indistinguishable; conventional cystoscopy and biopsy often become imperative. VC, for obvious reasons, is unable to provide tissue diagnosis, an ability possessed by cystoscopic biopsy. Ionic contrast, rarely used in current practice, is contraindicated in allergic patients and those with bilateral renal malfunction.\[6\] Magnetic-resonance-imaging VC is comparable with conventional and CT cystoscopy,\[8\] and can be used where contrast-enhanced CT is contraindicated. Nevertheless, VC holds promise in the evaluation of large bladder ulcers and adds a "third imaging dimension" that resembles conventional cystoscopy. Although more extensive evaluation is required, our case underscores its role in preliminary bladder “exploration.” This imaging advancement can serve as a follow-up tool for patients with bladder lesions and to monitor healing during and after treatment. Continuously evolving technology is making virtual detection of smaller lesions a reality.

References