Learning objectives

The purpose of this exhibit is to explain CT Cystography (CTC) and Virtual Cystoscopy (VC) with Dual Source technique. This work reviews the typical imaging findings of bladder carcinoma with MDCT cystography and virtual cystoscopy (VC). We present the CT cystography findings with virtual endoscopy correlation and bladder carcinoma appearance. CT cystography and VC are less invasive than conventional cystoscopy and can be used to evaluate areas difficult to assess with cystoscopy such as the anterior bladder neck and narrow-mouthed diverticula. Although uncommon, diverticular carcinoma is difficult to detect at conventional cystoscopy and has a poorer prognosis than neoplasm that originates within the main bladder lumen owing to earlier transmural invasion.

Background

CT cystography is a rapid evolving method, minimally invasive, for the evaluation of urinary bladder cancer that enables both two-dimensional (2D) and three-dimensional (3D) imaging. To date several papers have validated the optimal diagnostic accuracy of this technique in the evaluation of lesions greater than 5 mm, and in the local staging of the tumor. With regard to lesion size, it has also been demonstrated that multidetector-row CT (MDCT) performed with thin-slice reconstructions (1 mm) provide a good sensitivity for the detection of lesions <5 mm. Bladder carcinoma is the most common tumor among the low urinary tract, accounting for 90% of cancer cases. Conventional cystoscopy represents the gold standard for diagnosis and local management of bladder carcinoma and allows also the opportunity to perform immediate resection (curative or palliative) and obtain a tissue sample for histopathological examination. As the prevalence of transitional cell carcinoma is four-fold greater in men than in women, the endoscopic procedure presents objective difficulties related to the length and bending of male urethra. Despite the development of new cystoscopes and examination techniques, a most important problems still remains represented by intense discomfort for the patient and bleeding: in fact, its precluded in subjects with acute bleeding or urethral strictures; furthermore, the high cost, invasivity, and local complications such as infections and mechanical lesions are well-known drawbacks. Additionally, conventional cystoscopy does not
provide information about extramural extensions of the tumor. Moreover, even modern cystoscopes are often incapable of visualising correctly the bladder neck and luminal diverticula, especially in the anterior wall (sites that are often prone to mucosal dysplasia with malignant degeneration). CT cystography, combined with virtual cystoscopy, is mandatory for TNM staging of the tumor and also is useful when conventional cystoscopy is inconclusive or cannot be performed. The use of a new-generation MDCT combined with a high-resolution protocol with low values for slice thickness (0.6 mm), collimation (0.6 mm) and reconstruction increment (0.4 mm) enabled accurate, high resolution and fast exploration of the entire region of interest, offering reliable views for lesion detection.

**Imaging findings OR Procedure details**

Just before the CT examination, a Foley catheter (12-16 F) is positioned and the residual urine is drained. Then, the bladder is distended with 300-500 cm of room air according to the patient tolerance; it is very important that the bladder is well filled to identify any bladder wall thickening (Fig.1)

![Coronal images used for scoring bladder distension](image)

**Fig.** Coronal images used for scoring bladder distension

**References:** V. Panebianco; Department of Radiological Sciences, University of Rome, Rome, ITALY
Some authors prefer to distend the urinary bladder with contrast material as an alternative method (Fig. 2).

**Fig.**: The two methods of bladder distension: contrast material filled bladder (A) air-filled bladder (B).

**References**: V. Panebianco; Department of Radiological Sciences, University of Rome, Rome, ITALY

Scanning protocol depends on the available CT equipment, but with MDCT an effective slice thickness 0.6 mm and reconstruction interval 0.4 mm, kVp 120, effective mAs 200, are advisable. The most commonly used MDCT protocol comprises three phases. Unenhanced scan is acquired in supine position, before contrast medium injection, for the virtual endoscopy analysis; but in cases of significant amount of residual, it is necessary to acquire the same volume in prone position since the fluid residual could obscure bladder neck lesions (Fig. 3).
Fig.: A 66-year-old woman with a polypoid lesion on the anterior wall of the bladder. Transverse contrast-enhanced CT image in supine position reveals a 3 mm in diameter lesion of the bladder (A). On prone position the lesion is not detectable due to the presence of a large urine residual (B). Sagittal unenhanced images (C) On the volume-rendered image, endoluminal viewing, the lesion appears as a regularly shaped polyp (arrow) (D).

References: V. Panebianco; Department of Radiological Sciences, University of Rome, Rome, ITALY

Pre-contrast scan can also reveal wall calcifications that may be sometimes associated with transitional cell or squamous cell carcinoma. Post-contrast scans are acquired 70 s after bolus injection of non-ionic high osmolar contrast agent at a flow rate of 3 mL/s; and the third phase, pyelographic phase, 5-10 min following the contrast administration for the evaluation of the lower urinary tract and bladder. The latter phase can be useful to obtain a more densely opacified and more distended bladder. Datasets of images are transferred to a workstation (Syngo MMWP VE31A Win NT 5,2 Service Pack 2, COEM VE10D 64 Bit), suitable for 3D data management and reconstruction. Minimal
requirements for the analysis of CT cystography study includes visualization of the axial images, also reformatted axial and coronal images, and endoluminal views for VC.

Conventional cystoscopy is the standard method for the detection and direct visualization of bladder cancer; moreover, transurethral resection provides a histological diagnosis and staging information. However, it has several limitations: it is invasive, expensive, and time-consuming technique. Several complications may occur during a cystoscopy examination: infections, bladder perforation, scarring and stricture of the urethra. Additionally some bladder areas may be obscured at cystoscopy such as the anterior bladder neck, narrow-mouthed diverticula and in a trabeculated wall bladder (Fig. 4-5).

Fig.: A 60-year-old man hypertrophic bladder mucosa. On transverse CT images (A) the hypertrophic mucosal folds do not allow clear depiction of bladder wall. In contrast, the high spatial resolution of the volume rendered reconstructions permits an optimal definition of the bladder length (B) and images allows an intuitive discrimination between the curved mucosal folds (arrows)(C).

References: V. Panebianco; Department of Radiological Sciences, University of Rome, Rome, ITALY
Fig.: A 58-year-old man with multiple lesions (from 2 to 8 mm) on a hypertrophic bladder mucosa. On sagittal multiplanar reconstruction (MPR) (A) and transverse CT images (B), only three of four lesions are visualized, and the hypertrophic mucosal folds do not allow clear depiction of the remaining polyps. By contrast, the volume rendered images (C) allows a discrimination between the long, curved mucosal folds (arrowhead) and the polyps (arrows). Multifocal transitional cell carcinoma was diagnosed after endoscopic resection (D).

References: V. Panebianco; Department of Radiological Sciences, University of Rome, Rome, ITALY

In recent years, CT technology has undergone rapid development, with a consequent improvement in diagnostic accuracy of bladder tumor. In comparison with conventional cystoscopy, CTC and VC are less invasive and, in addition to depicting lesions directly, allow precise measurement of lesion size and evaluation of wall thickness. Furthermore, the 2D images permit evaluation of the locoregional extension of disease. However, to date, the role of CT cystography is limited to staging of the carcinomas (Fig. 6) and replacing cystoscopy when complications are present (urethral stricture, active bleeding, low patient compliance).
Fig.: In A Transverse contrast enhanced CT Image of a sessile mass (arrow), which involves the bladder wall without peri-vesical fat spreading. (T2). In B Transverse CT image of bladder carcinoma with peri-visceral fatty infiltration (white arrows) (T3). Note distension of the left ureter (black arrow). In C Bladder carcinoma of the posterior bladder wall which largely infiltrates the rectum (arrow)(T4).

References: V. Panebianco; Department of Radiological Sciences, University of Rome, Rome, ITALY

Since its first use, CT cystoscopy has demonstrated promising results for the diagnosis of bladder lesions. In fact, with the improved spatial resolution by the use of thinner slice thickness, collimation, and reconstruction increment its enable fast execution and high resolution of the examination. Moreover, it allows acquisition of multiplanar reformatted images (MPR) very similar to that of axial plane. A few studies in literature reported the combined evaluation of CT cystography, MPR, and virtual images increase the performance of the technique especially for the detection of small lesions (Fig. 7).

Fig.: A 55 years-old man with hematuria and positive citology. In A Transverse contrast enhanced CT image of a small sessile mass (white arrow) on hypertrophic mucosa (arrowhead). In B on the volume-rendered image, endoluminal viewing, the
lesion (white arrow) appears as a regularly shaped polyp on hypertrophic bladder mucosa (arrowhead).

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The contribution of the 3D approach was fundamental. Not only did it depict all lesions seen on 2D images, it also served as a diagnostic modality for lesions in subjects with suboptimal bladder distension and in two patients with irregular and hypertrophic mucosa.

Images for this section:

Fig. 1: Coronal images used for scoring bladder distension
**Fig. 2:** The two methods of bladder distension: contrast material filled bladder (A) air-filled bladder (B).
Fig. 3: A 66-year-old woman with a polypoid lesion on the anterior wall of the bladder. Transverse contrast-enhanced CT image in supine position reveals a 3 mm in diameter lesion of the bladder (A). On prone position the lesion is not detectable due to the presence of a large urine residual (B). Sagittal unenhanced images (C) On the volume-rendered image, endoluminal viewing, the lesion appears as a regularly shaped polyp (arrow) (D).

Fig. 4: A 60-year-old man hypertrophic bladder mucosa. On transverse CT images (A) the hypertrophic mucosal folds do not allow clear depiction of bladder wall. In contrast,
the high spatial resolution of the volume rendered reconstructions permits an optimal
definition of the bladder length (B) and images allows an intuitive discrimination between
the curved mucosal folds (arrows)(C).

Fig. 5: A 58-year-old man with multiple lesions (from 2 to 8 mm) on a hypertrophic bladder mucosa. On sagittal multiplanar reconstruction (MPR) (A) and transverse CT images (B), only three of four lesions are visualized, and the hypertrophic mucosal folds do not allow clear depiction of the remaining polyps. By contrast, the volume rendered images (C) allows a discrimination between the long, curved mucosal folds (arrowhead) and the polyps (arrows). Multifocal transitional cell carcinoma was diagnosed after endoscopic resection (D).
**Fig. 6:** In A Transverse contrast enhanced CT Image of a sessile mass (arrow), which involves the bladder wall without peri-vesical fat spreading. (T2). In B Transverse CT image of bladder carcinoma with peri-visceral fatty infiltration (white arrows) (T3). Note distension of the left ureter (black arrow). In C Bladder carcinoma of the posterior bladder wall which largely infiltrates the rectum (arrow) (T4).

**Fig. 7:** A 55 years-old man with hematuria and positive citology. In A Transverse contrast enhanced CT image of a small sessile mass (white arrow) on hypertrophic mucosa (arrowhead). In B on the volume-rendered image, endoluminal viewing, the lesion (white arrow) appears as a regularly shaped polyp on hypertrophic bladder mucosa (arrowhead).
Conclusion

CT virtual endoscopy is based on creating high contrast between wall bladder and lumen. It is achieved by administering air through a urinary catheter; however, some authors use a contrast material-filled method waiting the opacification of the bladder during the excretory phase. In our protocol, we used room air achieving adequate distension. Air-filled bladder provides optimal attenuation gradient between walls and lumen leading to differences greater than 1000 HU. Sensitivity and Specificity of these two methods are very striking: with slightly greater values for the latter method. Two main complications are reported for the air-filled method: CT data must be obtained in prone and supine position, and infection due to the use of room air. Potential allergies to contrast media and inability to perform the technique in patients with renal insufficiency are limitations of the contrast agent-filled method. CT cystography and VC are less invasive than conventional cystoscopy, and can be used to evaluate areas difficult to assess with cystoscopy (anterior bladder neck and narrow-mouthed diverticula). The main disadvantages of CT cystography and VC are the low sensitivity to depict flat lesions (carcinoma in situ) changes in mucosa texture, lack of distinguishing mucosal thickening secondary to fibrosis from a neoplasm, and certainly it lacks the ability to provide tissue for histologic evaluation. They are also unable to distinguish the infiltration of different layers of the wall bladder. In fact, it is difficult to establish if lesions invade the muscle layer or not, which is a critical information in order to choose conservative treatment (TURB) from radical cystectomy. Other disadvantages of VC include the inability to perform endoscopic resections or biopsies. Nevertheless, CTC combined with VC, particularly performed with 64-MDCT Dual Source provides a high level of diagnostic accuracy in detection of bladder lesions and is indicated for examination of patients on whom conventional cystoscopy is contraindicated, difficult to perform, unsatisfactory in interpretation, and as an adjuvant tool in the evaluation of areas difficult to assess with conventional cystoscopy.

Personal Information

References


