Comparative Study between Virtual Cystoscopy as a Non Invasive Technique and Conventional Cystoscopy in Detection of Bladder Lesions with Histopathological Correlation

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Abstract: The purpose of this study was to evaluate the usefulness of virtual cystoscopy using a volume rendering algorithm performed with multidetector CT in patients with different urinary bladder pathology compared with the histopathologic result. In our study about 50 examined individuals (10 females and 40 males) their ages ranging from 38 to 71 years (with 58 years mean age). These cases were classified into two main groups according to the technique; the first group subjected to virtual CT cystoscopy after air insufflation of the urinary bladder and the second group subjected to virtual CT cystoscopy after filling of the bladder by iodinated contrast material. The examination was well tolerated by all patients with no complications. All the cases underwent to conventional cystoscopy to confirm the diagnosis. In total, 58 lesions were detected with conventional cystoscopy while 53 lesions only detected on VC.

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Keyword: CTVC: computed tomography virtual cystoscopy,VC: virtual cystoscopy

1. Introduction:

The most common complaints in bladder diseases are microscopic and macroscopic hematuria, disuria and other voiding symptoms. All these symptoms may be related to inflammatory, neoplastic, stones, neurologic, obstructive or congenital abnormalities.

Ultrasound (US), urogram, computed tomography (CT), magnetic resonant imaging (MRI) and some other radiological modality have been used for a long time in all these pathologies. However, conventional cystoscopy is considered the gold standard for diagnosis and follow-up of bladder cancer but it has disadvantages such as high cost, patient discomfort, risk of urinary sepsis, and possible injury of the urethra with subsequent urethral stenosis render this procedure invasive **(Panebianco *et al.*,2009)**

Recently, three-dimensional computer-rendering techniques with rapid image acquisition have led to the development of virtual-reality imaging. With commercially available software, virtual-reality imaging allows interactive intra-luminal navigation through any hollow viscous, simulating conventional endoscopy **(Karabacak *et al.*,2011).**

2. Material and methods

The initial study included 50 examined individuals (10 females and 40 males) their ages ranging from 38 to 71 years (with 58 years mean age) they were presented by hematuria, disurea, frequency of micturation and other symptoms; they was referred from the outpatient clinic and investigated at different private places.

The examined individuals were classified into two main groups according to the technique used in examination as the following**:**

Group 1 (25 cases):

Subjected to spiral CT of the bladder after air insufflations of the bladder by room air with complete antiseptic measures, virtual CT cystoscopy was done in compared to the pathology report.

Group 2 (25 cases):

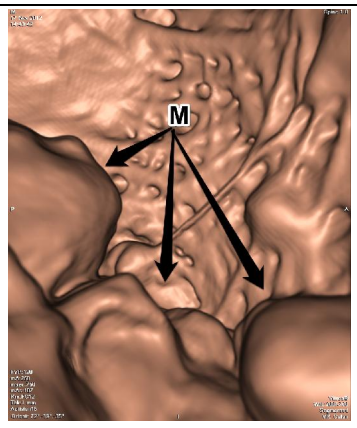
Subjected to spiral CT of the bladder after full of the bladder by iodinated contrast material, virtual CT cystoscopy was compared also to the pathology report.

All cases are subjected for detailed history taking (including the main complaint which was hematuria either gross or microscopic). Full general and local examination were done for all patients. Laboratory investigations including: CBC, renal function tests, liver function tests and coagulation profile. Radiological examinations including IVU (50 cases), and US (47 cases). CT scanning of the abdomen and pelvis with special thin cut on the pelvis area in both supine and prone positions. Every lesion observed on virtual cystoscopy was confirmed on conventional cystoscopy. So conventional cystoscopy was done in 50 cases and biopsy taken for them and Pathological assessment. The biopsies are stained with H&E stain and studied under microscopy.

VC Technique:

In the first group Any residual urine was drained through a 14-F Foley catheter, which was then used for insufflation of 200-500 cc. of room air according to the patient's tolerance under antiseptic precautions.

In the second group the bladder filled by contrast agent either by local injection of 200-250 cc. diluted iodinated contrast media using Foley's catheter, or by injection of 50-100 cc. of iodinated contrast prior to the examination by one hour. MDCT scan was performed (Aquilion 64, Toshiba Medical System Europe) for abdomen and pelvis including both IV and oral preparation. Spiral special thin cuts (3mm)on the bladder using the imaging protocol parameters of 1 mm collimation, 120 kV, 250 mA and 7 to 10 mm/sec table speed and 1 pitch factor in supine position, The scanning time was only 8-12 second. Subsequently, the patient was turned in prone position and a helical CT scan of the urinary bladder was repeated with the same parameters. The reason for the MDCT in prone position was to increase the accuracy in the 3D reconstruction of the bladder and to eliminate artifacts from residual urine. Each examination was performed using a single-breath-hold technique. The CT data were transferred to an independent workstation equipped with software for interactive intraluminal navigation with a surface-rendering algorithm. The first step towards surface rendering was segmentation. That is the method by which we could generate stereoscopic images of the inner wall of the bladder cavity from the original axial images that simulate the image seen using an endoscope. Additionally, areas of interest could be magnified and marked (figs. 1 & 2). The total time spent on study interpretation was approximately 5–8 minutes. The camera for virtual cystoscopy was placed in the center of the bladder lumen and thereafter was advanced to each quadrant in turn. When a possible abnormality was discovered, it was fully evaluated from various angles.



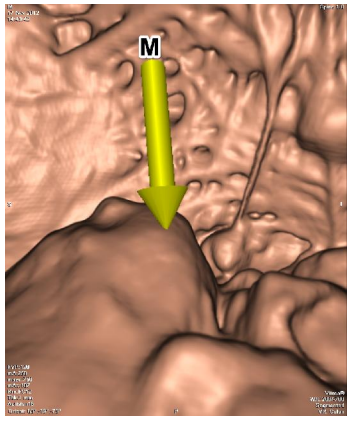


Fig.(1) VC image (after 3D reconstruction) showing multifocal exophytic lesions on the anterior and right lateral wall of the bladder. The pathology report revealed TCC of the urinary bladder.

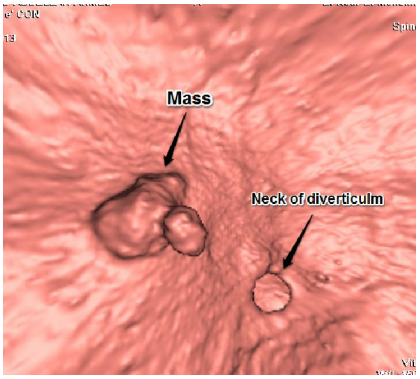


Fig (2) Virtual computed tomography image (after 3D reconstruction) showing exophytic mass lesion of the posterior wall of the bladder. The neck of the diverticulum is noted lateral to the mass.

The number, size, location and morphologic features of the lesions were evaluated on transverse and virtual images obtained from the patients both in supine and prone positions. Results of the virtual cystoscopy were compared with findings from the conventional cystoscopy and the histopathological findings for each patient.

3. Results

In group1 (air filled method): there were 28 lesions, virtual cystoscopy detected 27 of them with 96.4% delectability, the only one non detected lesion was subtle mucosal color changes detected by conventional cystoscopy and histopathological examination showed that it was a case of cystitis. While in group 2 (contrast filled method) : there were 30 lesions and virtual cystoscopy detected 26 of them with 86.6% delectability. The non detected lesions in contrast filled method were due to obscured small lesions which were less than 5mm by high density contrast within the urinary bladder(Table 1). There were no false positive findings in our study.

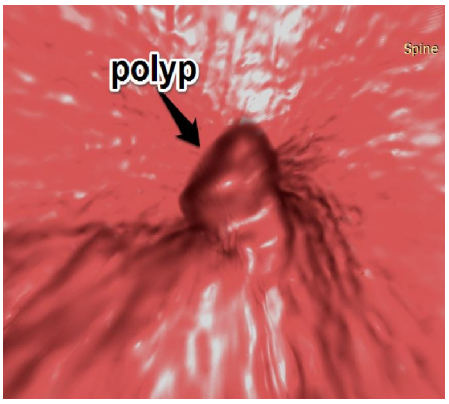
Table (1): Showing the number of detected lesions per every method of examination.

		DETECTION		
		Detected	**Not**	**Total**
GROUP	**Air filled**	27(96.4%)	1(3.6%)	28(100%)
	Contrast filled	26(86.6%)	4(13.4%)	30(100%)
Total		53(91.4)	5(8.6%)	58(100%)

The percentage of lesions detected in the whole study was 91.4% for both methods.

Table (3): Showing type of lesion detected in air filled and contrast filled techniques of virtual cystoscopy and their histopathological type as regard they benign or malignant

CT Virtual cystoscopy			**Conventional cystoscopy with histopathological findings**		
Lesion	**Air filled**	**Contrast filled**	**Total**	**benign**	**malignant**
Polyp	**11**	**8**	**19**	**12**	**7**
Sessile mass	**8**	**12**	**20**	**-**	**20**
Mucosal thickening	**3**	**4**	**7**	**4**	**3**
Diverticulae	**5**	**-**	**5**	**5**	**-**
Stone	**1**	**1**	**2**	**2**	**-**
Non detected by CTVC	**1**	**4**	**5**	**3**	**2**
Total	**28**	**30**	**58**	**25**	**33**



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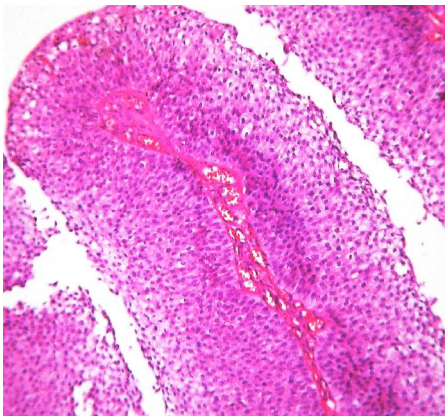

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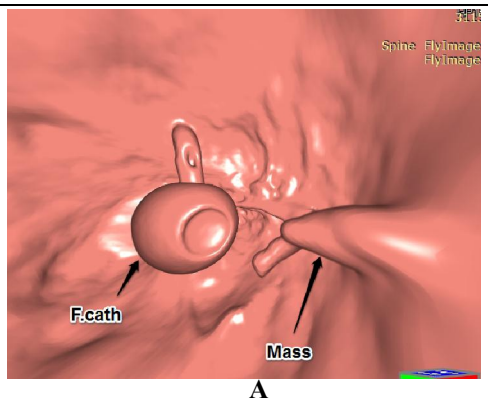
Fig (3) (a) Virtual computed tomography image (after 3D reconstruction) showing polypoidal lesion of the left lateral wall of the bladder. (b) Histopathological correlation shows Papillary urothelial carcinoma, low grade. Showed slender branched papillae lined by orderly arranged malignant cells with elongated nuclei and cytoplasmic vacuoltion.



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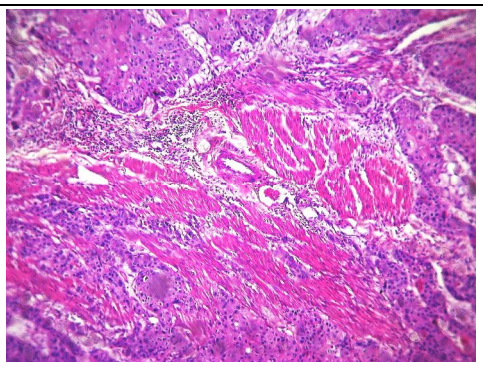

B

Fig (4) (a) Virtual computed tomography image (after 3D reconstruction) showing sessile mass lesion of the left lateral wall of the bladder. Balloon of the cathere is noted. (b) histopathological correlation showed Squamous cell carcinoma pT2 showed malignant Squamous cells invade the muscle layers (blue arrow)

4. Discussion

Conventional cystoscopy procedure has drawbacks, including its high costs and an invasiveness that may lead to iatrogenic bladder injury and urinary sepsis. CT is usually recommended as a useful radiologic approach for assessing bladder disease, but CT has low sensitivity for detection of small bladder lesions. For CT to depict a small bladder lesion, optimal imaging conditions, including adequate bladder distention and thin-slice scanning, must be satisfied. Therefore, negative findings on CT warrant performance of conventional cystoscopy in patients with bladder pathology **(Kivrak *et al.*,2009).**

An ultrasonography may be inadequate to detect tumors in the bladder dome, due to artifacts caused by intestinal loops, obesity and reverberation. Since ultrasonography is a real-time imaging method, it is essential that the user be experienced. Such disadvantages of conventional cystoscopy and ultrasonography have led to a search for noninvasive and reliable imaging techniques. **(Karabacak *et al.*,2011).**

Recently, three-dimensional computer-rendering techniques with rapid image acquisition have led to the development of virtual-reality imaging. With commercially available software, virtual-reality imaging allows interactive intraluminal navigation through any hollow viscous, simulating conventional endoscopy. **(Prando 2002).**

The urinary bladder is a good candidate for virtual endoscopy because of its simple luminal morphology, its relatively small volume, and the absence of involuntary peristalsis. Therefore, a virtual cystoscopic rendering of the bladder takes a short time to navigate and does not require that the operator have great skill. We found that after about 20 experiences of virtual cystoscopic navigation, we could complete an examination in less than 5 min (**Kim *et al.*,2005).**

We tried in this study to combine one procedure that can evaluate both extra-vesical evaluation as well as intra-vesical details that including mucosal pattern. CT virtual cystoscopy is a promising technique for use in bladder tumor detection of lesions larger than 5mm which was obviously shown in our study which includes 58 lesions we can detect 53 lesions by virtual cystoscopy while the last 5 lesion not detected as 4 of them were less than 5mm in maximum dimension and one case shows just subtle color change which not shown by VC.

Optimal evaluation requires adequate bladder distention with the patient in both supine and prone positions and interpretation of both transverse and virtual images. As in our study we found it is so useful procedure in follow-up as well as non fit patient for anaesthesia or surgical intervention.

In our study we detected 53 lesions of the urinary bladder 46 from them considered as mass lesions and the last 7 cases were 5 diverticulae and 2cases with urinary bladder stones. Each mass lesion was characterized as a focal polypoid lesion, a sessile mass, or wall thickening. A discrete lesion was considered polypoid (Fig. 3), if it was taller rather than wider, while a sessile mass was defined as a lesion when it was wider at the base (Fig. 4). A lesion was characterized as wall thickening when there was elevation of the bladder wall without a discrete mass. The main disadvantage of virtual CT in cases of mucosal thickening that it cannot differentiate between the neoplastic cause of mucosal thickening and inflammatory cause, so from here come the need of conventional cystoscopy for biopsy taken and histopathologic evaluation. The histopathological findings of the considered 46 bladder masses were 30cases were malignant bladder carcinoma and 16 cases of benign lesions or inflammatory process (cystitis) and from the 5 non detected cases there were 3 benign cases and 2 cases of malignant bladder carcinomas.

The usefulness of virtual cystoscopy for bladder tumor detection has already been proven. Virtual cystoscopy may obviate invasive procedures by providing reviewers with data that allow them to determine whether a patient's bladder has abnormalities. In addition, virtual cystoscopy can provide information regarding the lesion size, location, and shape to the surgeons who perform conventional cystoscopy **(Xinhua *et al.*, 2011).**

In our study we assess not only bladder carcinoma but also a variety of common bladder lesions causing hematuria like diverticulae, stones, and inflammatory conditions. Limitations of virtual CT cystoscopy of a contrast material-filled bladder include contraindication of the modality for patients who cannot tolerate IV contrast material injection. Additionally, in patients who cannot easily change position, the image quality of virtual cystoscopy is inevitably suboptimal because of inadequate mixing of the contrast material and urine. Third, using MDCT with a thin slice thickness may increase the radiation dose despite a shorter scanning time. Finally, possible scheduling problems may arise in a busy CT practice because of the repeated patient positioning and scanning required. We found bad techniques and percentage of undetected lesions is higher in the contrast filled method.

As compared to our study 96.4% detective percentage in group1 (Air filled method) in compare to only 86.6% detectability in group2 (contrast filled method) while there is 100% detectability in conventional cystoscopy with biopsy and histopathological correlations.

We can sum up that: Virtual CT cystoscopy is a

promising imaging modality for bladder evaluation in patients with gross hematuria. The adequate mixing of contrast material and urine in contrast filled method and proper insufflation of bladder with air in air filled method, attenuation-coefficient range used for voxel categorization, and degree of bladder distention are the key factors for obtaining a satisfactory evaluation **(Arslan *et al.*, 2006).**

We always recommend air filled method CT virtual cystoscopy for all patients with growth hematuria as a completion before going to conventional cystoscopy, negativity may be of value not to proceed other invasive maneuver. **(Kalokairinou *et al.*, 2014).**

Using the CTVC allows accurate localization of intra-luminal lesion due to its wide field of view and depiction of extra-vesical anatomic landmarks **(Kivrak AS *et al.*, 2009).**

However CTVC has several limitations. A major limitation is that it is unable to depict flat lesions, which appear as subtle mucosal color changes on conventional cystoscopy**.** Also the differentiation between small tumors and inflammatory swelling of the mucosa could be difficult, especially in patients with unsatisfactory bladder filling; Inflammatory swelling of the mucosa or fibrosis could be misdiagnosed as a tumor. Of course, one faces a similar problem on conventional cystoscopy because biopsy is often required to determine whether a bladder lesion is inflammatory, fibrotic, or neoplastic. Also the conventional cystoscopy has an advantage over CTVC in which it can evaluate the urethra as it is routinely assessed. **(Chou CP. *et al.*, 2005).**

Finally we concluded that the conventional cystoscopy with histopathological evaluation still the gold standard technique for bladder investigation however CT virtual cystoscopy especially air filled technique considered to be an alternative less invasive method for assessment of bladder lesions which gives image that more or less similar to that seen with conventional cystoscopy and by this technique we can minimize the un-necessary invasive un-comfortable techniques.

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