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# Role of CT Virtual Cystoscopy in Diagnosis of Urinary Bladder Neoplasm

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*Abstract:* **The aim of this review was to assess the role of computed tomography (CT) virtual cystoscopy (VC) in the diagnosing and evaluating urinary bladder carcinomas lesions. Comprehensive search through most popular database; PubMed was performed for all articles on Urinary bladder tumors diagnosis using computed tomography (CT) virtual cystoscopy (VC) imaging technique published in English language up to May, 2017. CT-VC is a lot less invasive, with minimum pain as well as risk for the patients, particularly in that there are no requirements for anaesthesia. It can be used to picture the bladder in a number of planes and offers intraluminal viewing of the bladder from any type of angle. VC is a viable strategy for use in discovery of bladder sores greater than 3 mm. some research studies recognized 77% of sores smaller than 10 mm. determined all the lesions smaller sized than 10 mm in their research of 13 patients. These research studies retrospectively evaluated bladder sores that had been confirmed on CPE.**

*Keywords:* **virtual cystoscopy (VC), computed tomography (CT), Urinary Bladder Neoplasm.**

## 1. INTRODUCTION

Urinary bladder carcinoma is the fourth most common tumor of the urinary system in men worldwide [(1)]. Bladder tumours are 4 times more common in men. A classic indication of bladder cancer is painless hematuria. Throughout the initial medical diagnosis, 70% of the cases are shallow, whereas in the remaining 30% the neoplasia has gotten into the muscle [(2)]. One of the most essential issues with urinary bladder tumours is disease reoccurrence. These reoccurrences could be due to advanced stages and grades. Tumours, which are limited to the mucosa, have a reoccurrence rate of 50% to 70% and a progression rate of 5% to 20% [(3,4)]. Numerous risk factors have actually been accused as being involved in its pathogenesis such as smoking, synthetic nitrogen fertilizers, fragrant amines, pelvic irradiation, a cyclophosphamide, chronic cystitis, Schistosomiasis, human papilloma infection, genetic predisposition, and some occupations. The relative importance of such risk factors in the pathogenesis of the disease varies in various populations [(5)].

Close monitoring of the patient is required. Conventional cystoscopy is the essential of diagnosis and follow-up of bladder neoplasia. Radiological imaging is generally used for the staging and follow-up of bladder tumours [(6)]. Cross-sectional imaging has had little or no function in the definitive diagnosis of patients in whom a bladder lesion is thought. Computed tomography (CT) and magnetic resonance imaging (MRI) are used mainly to demonstrate extravesical extension of the tumour and far-off metastasis [(7,8)]. On the other hand, current improvements in CT technology with fast image acquisition due to multidetector CT (MDCT) scanners combined with powerful three-dimensional software application have actually caused the development of virtual reality imaging [(9,10)]. The technique has currently been effectively it has actually shown to be useful complementary tool for the examination of the whole urinary system [(10)]. The precision of detecting bladder lesions (<1 cm) by computed tomography virtual cystoscopy (CTVC) has been variously reported varying within 60--100% [(11)]. Even bladder lesions <5 mm have also been reportedly found by some authors using CTVC [(12,13)], while others have actually discovered the visualization of such lesions to be hard [(13)]. This innovation is thought about safe for bladder cancer follow-up with detection rates similar to traditional cystoscopy.

**The aim of this review was to assess the role of computed tomography (CT) virtual cystoscopy (VC) in the diagnosing and evaluating urinary bladder carcinomas lesions.**

## 2. METHODOLOGY

Comprehensive search through most popular database; PubMed was performed for all articles on Urinary bladder tumors diagnosis using computed tomography (CT) virtual cystoscopy (VC) imaging technique published in English language up to May, 2017. Relevant papers on the working mechanism or clinical performance of the techniques were selected. Search strategy of this paper used the search terms “bladder cancer” and “Computed tomography (CT) virtual cystoscopy (VC)”. Reference lists of retrieved papers were manually reviewed for additional relevant articles.

## 3. RESULTS

- **CT, VC Procedure:**

Just before the CT examination, a Foley catheter (12– 16 F) is positioned and the residual urine is drained [13]. Then, the bladder is distended with 300–500 cm3 of room air according to the patient tolerance; it is very important that the bladder is well filled to identify any bladder wall thickening (**Figure1**). Some authors prefer to distend the urinary bladder with contrast material as an alternative method [14,15] (**Figure 2**). Scanning protocol depends on the available CT equipment, but with MDCT an effective slice thickness 3 mm or less and reconstruction interval 3–1 mm, kVp 120, effective mAs 240, are advisable [16]. 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 (**Figure 3**). Pre-contrast scan can also reveal wall calcifications that may be sometimes associated with transitional cell or squamous cell carcinoma [17].

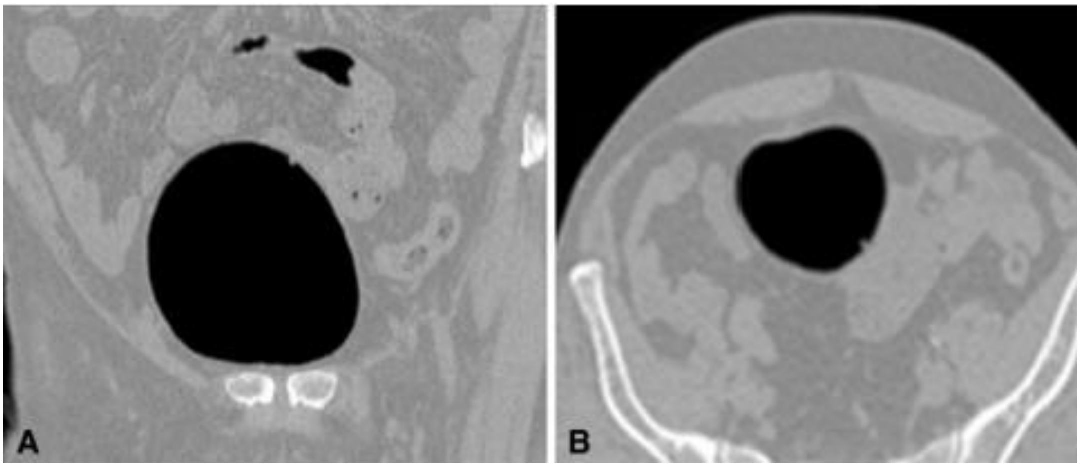


**Figure 1: Coronal and axial images used for scoring bladder distension (A): optimal AP diameter >15 cm whereas satisfactory with AP diameter between 10 and 15 cm (B), poor distension with AP diameter**

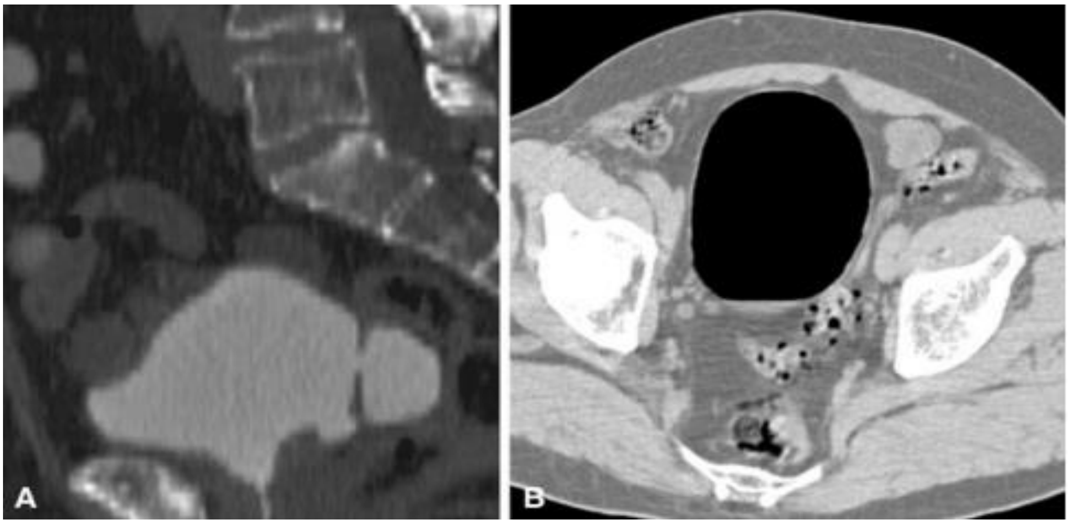


**Figure 2: A Contrast material filled bladder and B air filled bladder**

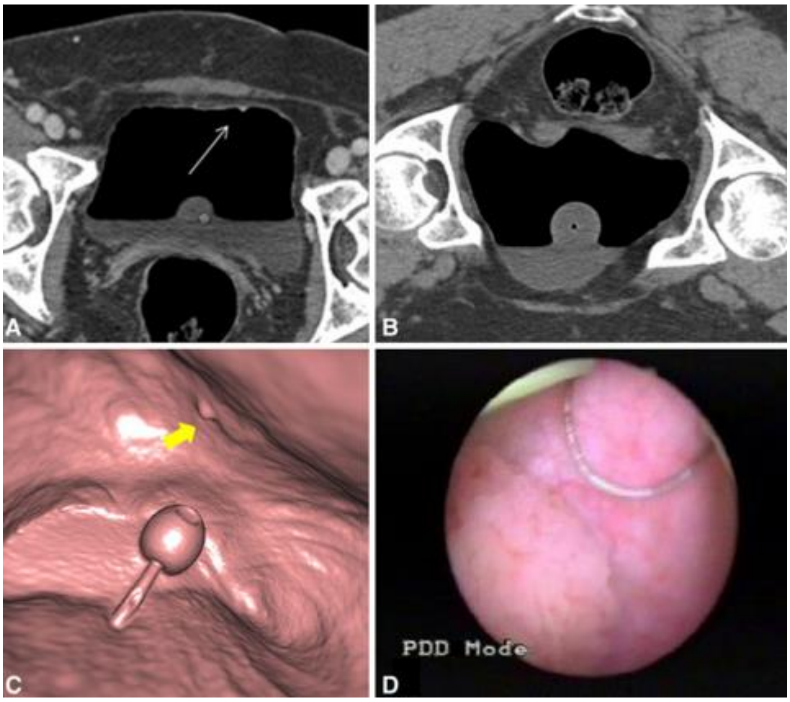


**Figure 3: Transverse contrast-enhanced CT image in supine position reveals a 3 mm in diameter lesion of the bladder. On prone position the lesion is not detectable due to the presence of a large urine residual (B). On the volume-rendered image, endoluminal viewing, the lesion appears as a regularly shaped polyp (arrow) (C). Histopathological examination after resection during conventional cystoscopy demonstrated the presence of transitional cell carcinoma (D)**

- **Evidence supporting this study:**

A number of imaging techniques are available for usage in the discovery of bladder pathology. United States, urogram, CT, MRI as well as standard cystoscopy could be used in the bladder disease. Traditional cystoscopy was accepted as a gold standard in bladder [(18)]. There are numerous downsides of the standard cystoscopy. It is usually hard to perform appropriately when discovering the former bladder wall or a diverticulum tooth cavity. Primary intradiverticular cancers are uncommon, however medical diagnosis is frequently hard with traditional technique [(19,20,21,22)]. There are some contraindications for the standard cystoscopy such as bacteriuria, acute cystitis, urethritis, prostatitis, obstructive prostatic hypertrophy, and also stricture or rupture of the urethra. Marked hematuria is one more factor that limits the technical success of cystoscopy, thus decreasing its reliability. On the other hand, cystoscopy is carried out in regional or basic anesthesia and also it is an invasive and also uncomfortable procedure for patients, and issues such as infections, uretral or bladder perforation, scarring, and also stricture of the urethra have actually been observed (**Figure 4**) [(23,24,25,26)].

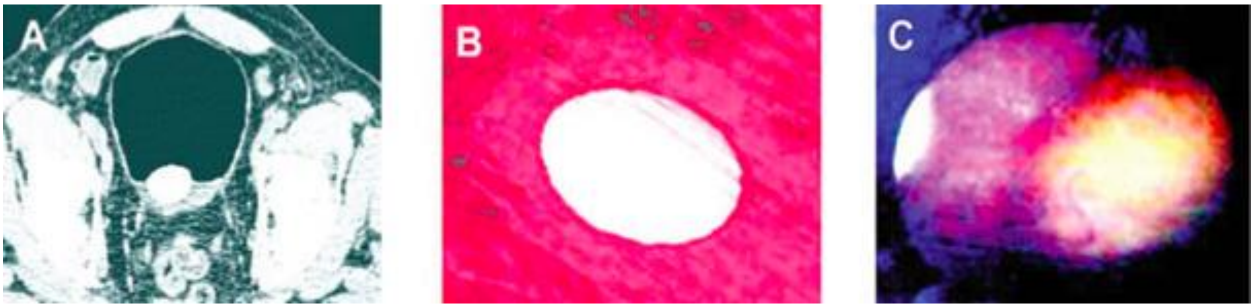

**Figure 4: CT scan conventional cystoscopy**

After the first report of online cystoscopy in study by Vining et al., there have actually been a lot of research studies on the energy of digital cystoscopy of bladder. Urinary bladder is a good organ for online cystoscopy due to its simple luminal morphology, reasonably tiny volume, and also absence of uncontrolled peristalsis. Online cystoscopic rendering of bladder takes less time to navigate and also does not call for great ability on the component of operator [(27,28,29)]. According to a research study by Kim et al., digital cystoscopy was found above multiplanar reconstruction and source CT photos for sore detection on the other hand product loaded bladder [(30)].

A current meta-analysis of 26 studies done by Qu et al. has actually reported pooled sensitivity and uniqueness of virtual cystoscopy to be 93.9% as well as 98.1%, specifically [31]. CTVC is a fairly noninvasive arising device in the diagnostic armamentarium of bladder pathology. In 1996, Vining et al. were the initial to report the feasibility of VC in one healthy volunteer and 2 patients with biopsy-proven TCC of the bladder [32]. Based upon a variety of records, VC became a promising method in obtaining both extravesical and intravesical imaging details, with outcomes comparable to that of standard cystoscopy in the discovery of bladder lesions [33,34]. Reduced level of sensitivity rates were reported for lesions smaller sized than 1 centimeters, Kim et al. later on upgraded the sensitivity of the approach by utilizing a slice thickness of 1.25 mm [30]. MDCT scanners demonstrate benefits such as: the ability to cover extensive structural quantities incorporated with the considerably minimized examination time, which is vital for reduction of activity artifacts. Along with the above, the considerable decrease of section collimation, have actually entirely reinvented the imaging modern technology [35]. VC with MDCT allows a quick and also thorough assessment of the urinary bladder as well as pelvic region, with satisfactory results in detecting bladder sores, specifically small-sized exophytic tumors [36].

As a minimally intrusive procedure to spot exophytic sores of the bladder mucosa, VC has several advantages over traditional cystoscopy. The volumetric imaging data obtained with helical CT is computer system rendered to generate three-dimensional images as well as with readily available software program, intraluminal navigating with any kind of hollow organ can be feasible. The VC images can also be kept in a data source helping with sore contrast during follow-up. Furthermore, the dimension of a lesion can be gauged quickly as well as objectively [34]. In addition, discovery of a tumor within a diverticulum is possible with the help of software program reconstruction devices also in cases where the slim neck of the diverticulum might provide cystoscopy extremely difficult. Patients with an extreme urethral stricture, who may be poor candidates for traditional cystoscopy, can safely undergo VC regarding a great catheter can be placed in the bladder effectively. The signs may be included kids where cystoscopy is troublesome along with in patients with high risk of iatrogenic hemorrhage [30,31]. The usage of transverse images throughout VC enables for assessment of additional pelvic pathologies, extravesical metastases, or also clinically positive pelvic lymph nodes [30].

- **Advantage and accuracy of CT-CV:**

In a very important study [37] that was conducted from June 2013 to June 2014, 50 patients (46 men, 4 females) with background and also examinations suggestive of urothelial cancer, with mean age 62.76 ± 10.45 years, underwent CTVC by a radiologist based on procedure as well as ultimately underwent conventional cystoscopy (CPE) the very same day or the next day. An overall of 80 tumor sores was discovered in 25 favorable patients in CPE. Solitary tumor was discovered in thirteen patients, two lesions were found in two patients, and also greater than two were found in 10 patients. Aside from one CIS and also 4 other tumors which were missed on CTVC, all other tumor sores were understood precision with regard to placement and also distribution as on CPE [37]. In this study, standard as well as digital cystoscopy were comparable in detection of tumor development in urinary system bladder. The tumor dimension ranged from 0.2 cm to 5.0 centimeters in maximum measurement [37]. Amongst the envisioned 80 tumors, 31 lay at the best lateral wall surface (**Figures 5**), sixteen on left lateral wall surface, twelve at the posterior wall, 10 at the base, 6 at the dome, and 4 sores in the diverticulum (Figure 5(c)) as well as one was a situation of Carcinoma in situ (CIS) [37]. The precision of detecting bladder lesions (<1 cm) by computed tomography virtual cystoscopy (CTVC) has actually been otherwise reported ranging within 60 - 100% [37,38,39]. Also bladder sores <5 mm have actually likewise been reportedly spotted by some authors making use of CTVC, while others have actually discovered the visualization of such lesions to be hard [39]. This modern technology is taken into consideration safe for bladder cancer follow-up with detection rates similar to conventional cystoscopy.

For the size (depth) of the mass, the here and now research revealed a level of sensitivity of 100% for detecting bladder masses, consisting of those of 5 - 10 mm, by CT-VC in all cases, as well as 90% sensitivity for assessing masses of ⩽ 5 mm. Numerous studies have actually reported various results. Narumi et al. [39] found the discovery and characterisation of masses of <10 mm to be difficult utilizing a 3D screen of helical CT information, while Fenlon et al. [40] reported that all of the bladder masses spotted at CC were visualised at CT-VC, as well as reported that tumors of <10 mm were recognized, although this group did not report the number of their masses were <5 mm. In their study, Song et al. [41] showed that VC is a practical method for detecting bladder masses of < 5 mm. In their research study, Song et al. [41] revealed that VC is a practical method for identifying bladder masses of > 5 mm, but also for lesions of ⩽ 5 mm the detection rate was 60 %. Kim et al. [42] reported an exceptional arrangement in between VC as well as CC, with a high sensitivity and also specificity, and their detection rate for sores of <5 mm was 88%. Tsili et al. [43] found all 30 bladder lesions in 24 patients, but that research included only 4 sores of <5 mm, while Constantine et al. [44] spotted 18 sores on

CT-VC, of 20 lesions with a size of ⩽ 5 mm on CC. These various outcomes might be attributed to the various kinds of CT scanners made use of, various parameters utilized during the CT evaluations, and also variable levels of experience in the analysis of VC [43,44]. The reported staging precision of traditional CT in staging of urinary bladder cancer is as low as 40 - 60% [45] Conventional CT cannot distinguish non-muscle intrusive from muscle-invasive bladder cancer, additionally could not find tiny perivesical spread of tumor. Detection of macroscopic tumor extension can also be troublesome. Perivesical soft-tissue stranding is a nonspecific finding as well as can be as a result of tumor or merely edema [46].

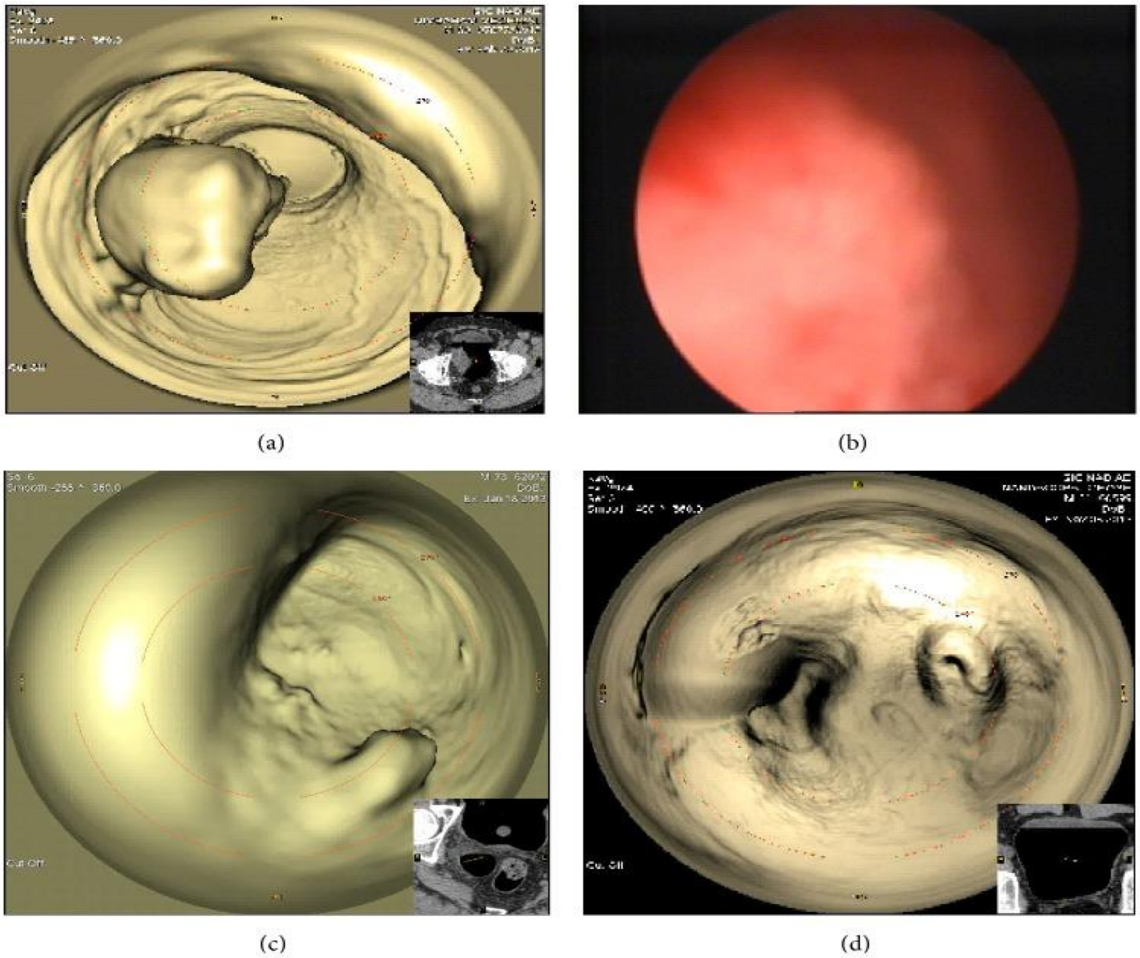


**Figure 5: (a-b) Large right lateral wall growth in a patient presenting with gross painless hematuria on CTVC and CPE, respectively. (c) CTVC image of inside the bladder diverticulum showing papillary lesions. (d) Follow-up case of TCC bladder with normal findings on CTVC.**

## 4. CONCLUSION

CT-VC is a lot less invasive, with minimum pain as well as risk for the patients, particularly in that there are no requirements for anaesthesia. It can be used to picture the bladder in a number of planes and offers intraluminal viewing of the bladder from any type of angle. VC is a viable strategy for use in discovery of bladder sores greater than 3 mm. some research studies recognized 77% of sores smaller than 10 mm. determined all the lesions smaller sized than 10 mm in their research of 13 patients. These research studies retrospectively evaluated bladder sores that had been confirmed on CPE.

## REFERENCES

[1] R. Vikram, C.M. Sandler, C.S. Ng. Imaging and staging of transitional cell carcinoma: Part 1. Lower urinary tract. AJR, 192 (2009), pp. 1481–1487

[2] Kirkali Z, Chan T, Manoharan M, et al. Bladder cancer: epidemiology, staging and grading, and diagnosis. Urology. 2005;66:4–34.

[3] Josephson DY, Pasin E, Stein JP. Superficial bladder cancer: part 1. Update on etiology, classification and natural history. Expert Rev Anticancer Ther. 2006;6:1723–34.

[4] Schmidbauer J, Lindenau G. Follow-up of nonmuscle invasive transitional cell carcinoma of the bladder: how and how often? Curr Opin Urol. 2008;18:504–7.

[5] A.H. Zarzour, M. Selim, A.A. Abd-elsyaed, et al. Muscle invasive bladder cancer in Upper Egypt: the shift in risk factors & tumor characteristics. BMC Cancer, 8 (2008), p. 250.

[6] Ng CS. Radiologic diagnosis and staging of renal and bladder cancer. Semin Roentgenol. 2006;41:121–38.

[7] Tekes A, Kamel I, Imam K, et al. Dynamic MRI of bladder cancer: evaluation of staging accuracy. AJR Am J Roentgenol. 2005;184:121–7.

[8] Baltaci S, Resorlu B, Yagci C, et al. Computerized tomography for detecting perivesical infiltration and lymph node metastasis in invasive bladder carcinoma. Urol Int. 2008;81:399–402.

[9] H. Arslan, K. Ceylan, M. Harman, Y. Yilmaz, O. Temizoz, and S. Can, “Virtual computed tomography cystoscopy in bladder pathologies,” *International Brazilian Journal of Urology*, vol. 32, no. 2, pp. 147–154, 2006.

[10] Battista, C. Sassi, R. Schiavina et al., “Computerized tomography virtual endoscopy in evaluation of upper urinary tract tumors: initial experience,” *Abdominal Imaging*, vol. 34, no. 1, pp. 107–112, 2009.

[11] Inamoto K., Kouzai K., Ueeda T., Marukawa T. CT virtual endoscopy of the stomach: comparison study with gastric fiberscopy. *Abdominal Imaging*. 2005;30(4):473–479. doi: 10.1007/s00261-004-0278-0.

[12] Panebianco V., Osimani M., Lisi D., et al. 64-Detector row CT cystography with virtual cystoscopy in the detection of bladder carcinoma: preliminary experience in selected patients. *Radiologia Medica*. 2009;114(1):52–69. doi: 10.1007/s11547-008-0350-x.

[13] Fenlon HM, Bell TV, Ahari HK, et al. (1997) Virtual cystoscopy: early clinical experience. Radiology 205:272–275

[14] Song JH, Francis IR, Platt JF, et al. (2001) Bladder tumor detection at virtual cystoscopy. Radiology 218:95–100

[15] Kivrak AS, Kiresi D, Emlik D, et al. (2009) Comparison of Ct virtual cystoscopy of the contrast material-filled bladder with conventional cystoscopy in the diagnosis of bladder tumours. Clin Radiol 64:30–37

[16] Kalra MK, Saini S, Rubin GD, MDCT from protocols to practice 2008, Springer

[17] Caoili EM, Cohan RH, Korobkin M, et al. (2002) Urinary tract abnormalities: initial experience with multi-detector row urography. Radiology 222:353–360

[18] Song JH, Francis IR, Platt JF, Cohan RH, Mohsin J, Kielb SJ, et al.: Bladder tumor detection at virtual cystoscopy. Radiology. 2001; 218: 95-100.

[19] Lammle M, Beer A, Settles M, Hannig C, Schwaibold H, Drews C: Reliability of MR imaging-based virtual cystoscopy in the diagnosis of cancer of the urinary bladder. AJR Am J Roentgenol. 2002; 178: 1483-8.

[20] Zantl N, Beer A, van Randenborgh H, Hartung R: Virtual endoscopy of the urinary tract. Urologe A. 2002; 41: 552-8.

[21] Sakamoto Y, Tanaka H, Kawabata G: Inflammatory pseudotumor of the urinary bladder diagnosed using 3D-CT cystoscopy. Hinyokika Kiyo. 2003; 49: 587-90.

[22] Durfee SM, Schwartz LH, Panicek DM, Russo P: MR imaging of carcinoma within urinary bladder diverticulum. Clin Imaging. 1997; 21: 290-2.

[23] Stephenson WT, Holmes FF, Noble MJ, Gerald KB: Analysis of bladder carcinoma by subsite. Cystoscopic location may have prognostic value. Cancer. 1990; 66: 1630-5.

[24] Baniel J, Vishna T: Primary transitional cell carcinoma in vesical diverticula. Urology. 1997; 50: 697-9.

[25] Bavetta S, Olsha O, Fenely J: Spreading sepsis by cystoscopy. Postgrad Med J. 1990; 66: 734-5.

[26] Mosbah A, Kane A, Zhani R, Hattab C: Iatrogenic urethral strictures of the male urethra. Acta Urol Belg. 1990; 58: 87-93.

[27] Vining D. J., Zagoria R. J., Liu K., Stelts D. CT cystoscopy: an innovation in bladder imaging. *American Journal of Roentgenology*. 1996;166(2):409–410. doi: 10.2214/ajr.166.2.8553956.

[28] Kaway N, Mimura T, Nagata D, et al. (2004) Intravenous urography-virtual cystoscopy is a better preliminary examination than air virtual cystoscopy. BJU Int 94:382–386

[29] Yazgan C., Fitoz S., Atasoy C., Turkolmez K., Yagci C., Akyar S. Virtual cystoscopy in the evaluation of bladder tumors. *Clinical Imaging*. 2004;28(2):138–142. doi: 10.1016/s0899-7071(03)00117-7.

[30] Kim J. K., Park S.-Y., Kim H. S., Kim S. H., Cho K.-S. Comparison of virtual cystoscopy, multiplanar reformation, and source CT images with contrast material-filled bladder for detecting lesions. *American Journal of Roentgenology*. 2005;185(3):689–696.

[31] Qu X., Huang X., Wu L., Huang G., Ping X., Yan W. Comparison of virtual cystoscopy and ultrasonography for bladder cancer detection: a meta-analysis. *European Journal of Radiology*. 2011;80(2):188–197. doi: 10.1016/ j.ejrad.2010.04.003.

[32] D. J. Vining, R. J. Zagoria, K. Liu, and D. Stelts, "CT cystoscopy: an innovation in bladder imaging," *The American Journal of Roentgenology*, vol. 166, no. 2, pp. 409–410, 1996.

[33] H. M. Fenlon, T. V. Bell, H. K. Ahari, and S. Hussain, "Virtual cystoscopy: early clinical experience," *Radiology*, vol. 205, no. 1, pp. 272–275, 1997.

[34] Y. Narumi, T. Kumatani, Y. Sawai et al., "The bladder and bladder tumors: imaging with three-dimensional display of helical CT data," *The American Journal of Roentgenology*, vol. 167, no. 5, pp. 1134–1135, 1996.

[35] T. G. Flohr, S. Schaller, K. Stierstorfer, H. Bruder, B. M. Ohnesorge, and U. J. Schoepf, "Multi-detector row CT systems and image-reconstruction techniques," *Radiology*, vol. 235, no. 3, pp. 756–773, 2005.

[36] C. Tsampoulas, A. C. Tsili, D. Giannakis, Y. Alamanos, N. Sofikitis, and S. C. Efremidis, "16-MDCT cystoscopy in the evaluation of neoplasms of the urinary bladder," *The American Journal of Roentgenology*, vol. 190, no. 3, pp. 729–735, 2008.

[37] Abrol S, Jairath A, Ganpule S, et al. Can CT Virtual Cystoscopy Replace Conventional Cystoscopy in Early Detection of Bladder Cancer? *Advances in Urology*. 2015;2015:926590. doi:10.1155/2015/926590.

[38] Yun J. Y., Ro H. J., Park J. B., et al. Diagnostic performance of CT colonography for the detection of colorectal polyps. *Korean Journal of Radiology*. 2007;8(6):484–491. doi: 10.3348/kjr.2007.8.6.484.

[39] Inamoto K., Kouzai K., Ueeda T., Marukawa T. CT virtual endoscopy of the stomach: comparison study with gastric fiberscopy. *Abdominal Imaging*. 2005;30(4):473–479. doi: 10.1007/s00261-004-0278-0.

[40] Narumi Y., Kumatani T., Souvai Y., Kuriyama K., Kuroda C., Takahashi S. The bladder and bladder tumors: imaging with three-dimensional display of helical CT data. Am J Roentgenol. 1996;167:1134–1135.

[41] Fenlon H.M., Bell T.V., Ahari H.K., Hussain S. Virtual cystoscopy, early clinical experience. Radiology. 1997;205:272–275.

[42] Kim J.K., Ahn J.H., Park T., Ahn H.J., Kim C.S., Cho K.S. Virtual cystoscopy of the contrast material-filled bladder in patients with gross hematuria. AJR. 2002;179:763–768.

[43] Tsili A.C., Tsampoulas C., Chatziparaskevas N., Silakos A., Kalef-Ezra J., Sofikitis N. Computed tomographic virtual cystoscopy for the detection of urinary bladder neoplasms. Eur Urol. 2004;46:579–585.

[44] Tsampoulas C., Tsili A.C., Giannakis D., Alamanos Y., Sofikitis N., Efremidis S.C. 16-MDCT cystoscopy in the evaluation of neoplasms of the urinary bladder. AJR. 2008;190:729–735.

[45] J. Zhang, S. Gerst, R.A. Lefkowitz, *et al.* Imaging of bladder cancer Radiol Clin North Am, 45 (2007), pp. 183–205

[46] R.H. Cohan, E.M. Caoili, N.C. Cowan, *et al.* MDCT urography: exploring a new paradigm for imaging of bladder cancer. AJR, 192 (2009), pp. 1501–1508