

ASSISTED VIRTUAL CYSTOSCOPY IN THE CONDITION
OF RETROGRADE CT CYSTOGRAPHY IN PATIENTS
WITH CHRONIC KIDNEY DISEASE

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Abstract

Virtual CT cystoscopy is an imaging method that allows assessing of bladder wall for possible intraluminal formations. It can give a preliminary idea about the number, size and location of the lesions and their relationship to the bladder wall. The most common method of virtual cystoscopy is to apply contrast material intravenously and follow its excretion. However, this method is not applicable in patients with chronic kidney disease (CKD). For this reason we have developed and introduced for the first time in our country an alternative method suitable for this group of patients. It is based on the homogeneous filling of the bladder with a contrast agent during preliminary catheterization, thanks to which quality images are obtained – assisted virtual cystoscopy in conditions of CT cystography.

A total of 44 patients with hematuria underwent assisted virtual cystoscopy during retrograde CT cystography: as a primary examination in 35 cases (79.5%) and as a control study in 9 patients (20.5%) with a history of proven superficial non-muscle invasive bladder cancer. From the performed conventional urethrocystoscopy in 12 patients (27%) formations ≤ 4 mm were found, which did not have a specific diagnostically significant CT image. In 32

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patients (73%) formations greater than ≥ 4 mm in diameter were observed and it was found that there is 100% coincidence in terms of location, shape and the dimensions of the volumetric process.

Assisted virtual cystoscopy in retrograde CT cystography is a method with good diagnostic results in patients with CKD and hematuria of bladder origin.

Key words: assisted virtual cystoscopy, CT cystography, chronic kidney disease, bladder cancer

Introduction. Virtual CT cystoscopy is an imaging method that allows assessing of bladder wall for possible intraluminal formations. It can give a preliminary idea about the number, size and location of the lesions and their relationship to the bladder wall. This method is introduced with the development of computed tomography and is highly dependent on its quality. There are several types of virtual cystoscopy depending on how the bladder is contrasted. One of the methods still practiced today is the evacuation of the contents of the bladder followed by insufflation of air. Another method is to use the contents of the bladder with density characteristics close to those of water. The most common method is to apply contrast material intravenously and follow its excretion [1,2]. Ten years ago, our team developed and introduced a modified method of CT urography with antegrade virtual cystoscopy based on the homogeneous filling of the bladder with contrast urine, which enables extremely high quality images to be obtained [3].

However, this method is not appropriate in patients with chronic kidney disease (CKD) and it is advisable to search for alternative methods.

For this reason we have developed and introduced for the first time in our country an alternative method suitable for this group of patients. It is based on the retrograde homogeneous filling of the bladder with a contrast agent during preliminary catheterization, thanks to which quality images are obtained – assisted virtual cystoscopy in conditions of retrograde CT cystography.

Material and methods. The study population consists of 44 patients who underwent assisted virtual cystoscopy during retrograde CT cystography. Of these, 41 patients had CKD and hematuria and 3 patients had hematuria and a proven allergy to contrast agents. The possibility for contrast examination is directly dependent on the patient's general condition, cardiovascular function, creatinine level and creatinine clearance. In patients with CKD (glomerular filtration rate [eGFR] 60–90 ml/min/1.73 m²) and creatinine levels above 130 μ mol/l, there is a high risk of renal function impairment and those patients were indicated for CT urography with virtual cystoscopy. It should be noted that in most cases assisted virtual cystoscopy during retrograde CT cystography is performed on the occasion of CKD and hematuria. The presence of blood in the urine significantly impairs the homogenization of the contrast agent, which further impairs the quality of the study. For all these reasons and in order to obtain quality images in patients with CKD at the beginning of the study we fix a urethral catheter. We introduce 50 to 100 ml of contrast material through the catheter after evacuation

of a similar volume of urine. Subsequently, when the patient is physically able, we change the position or verticalize them. The aim is to distribute the introduced contrast material evenly in the bladder.

To achieve quality images in conventional CT and perform assisted virtual cystoscopy, we conduct a multiphase CT examination of 16-channel multi-slice CT GE Optima, and use a post-processing workstation ADW 4.6. The parameters of CT are: 140 kV, mA auto up to 250, cut thickness at 16 channel CT 16×1.25 , i.e. with the possibility of reconstruction of 1.25 mm, pitch 1.63. Post-processing is performed on the secondarily reconstructed axial sections 1.25 mm, using the capabilities of MPR, MIP, Volume rendering and navigation. We use these parameters in both the early and the “cystographic” phase.

The most important part of the study is the uniform homogeneous filling of the bladder. To avoid unnecessary irradiation of the patient, we take a single sagittal section through the middle area of the bladder to verify the uniform filling and check the homogeneity of the contents, using moderate scan parameters with respect to kV and mA. There is no absolute requirement for a maximum filled bladder. The ability to urinate as well as the verticalization of the patient give better results.

After the bladder is filled, a repeated spiral scan with the already noted parameters is performed, the aim being to create three-dimensional urography and the possibility for virtual endoscopy – the second phase of the examination. The post-processing is performed on the secondary reconstructed sections $\times 1.25$ mm, using the capabilities of the specified workstation, in terms of MPR, MIP, Volume rendering. A detailed examination of the structures of the small pelvis is performed: structure of the bladder wall, vascularization and deformities. The structure of the adipose tissue in the pelvis as well as the vascular lumens are monitored.

Results. For a period of two years (2017–2019) Assisted virtual cystoscopy during retrograde CT cystography was performed in 44 patients. Of these, 41 (93%) had CKD (G1–G4) and 3 (3%) patients had hematuria and a proven allergy to contrast agents. Demographic data was: 23 male patients (52.3%) and 21 female patients (47.7%) with an average age of 75.5 years (63–88).

Assisted virtual cystoscopy during retrograde CT cystography was performed as a primary examination in 35 cases (79.5%), due to intermittent macroscopic hematuria, in patients without a previous history of bladder cancer and in 9 cases as a control study (20.5%), in patients with a history of superficial non-muscle invasive bladder cancer.

In the primary examinations we proved a volumetric process, which was assumed by other diagnostic methods and was established by conventional computed tomography plus virtual cystoscopy (Fig. 1–4).

The results of the performed virtual cystoscopies during retrograde CT cystography were compared with the results of conventional white light urethrocy-



Fig. 1. Native CT of the small pelvis

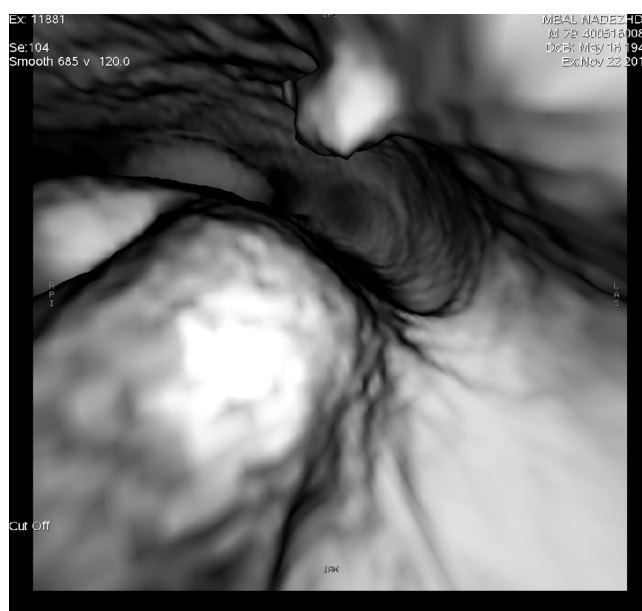


Fig. 2. Virtual cystoscopy during CT cystography

toscopy performed in all patients. From the performed conventional urethrocystoscopy in 12 patients (27%) formations ≤ 4 mm were found, which did not have a specific diagnostically significant CT image. In 32 patients (73%) who underwent CT with virtual cystoscopy and formations greater than 4 mm in diameter were observed, after performing conventional cystoscopy to verify the process, it was found that there is 100% coincidence in terms of location, shape and the dimensions of the volumetric process.

Discussion. It is suggested that urinary bladder may be an ideal intra-abdominal organ for virtual endoscopic examination because of its simple luminal morphology, small volume and the absence of peristalsis [4]. Assisted virtual

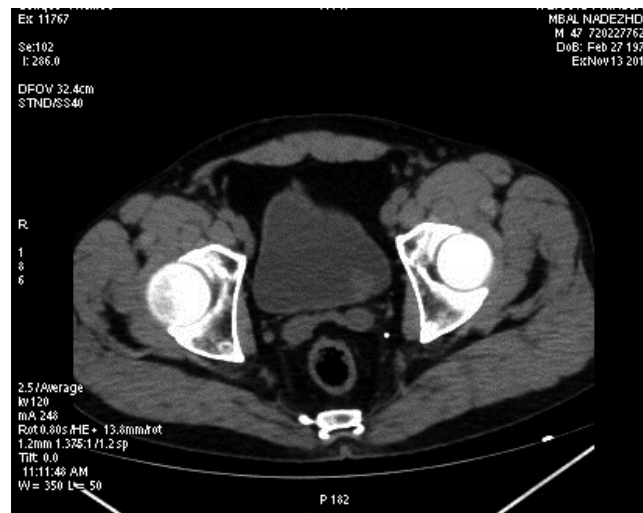


Fig. 3. Native CT of the small pelvis

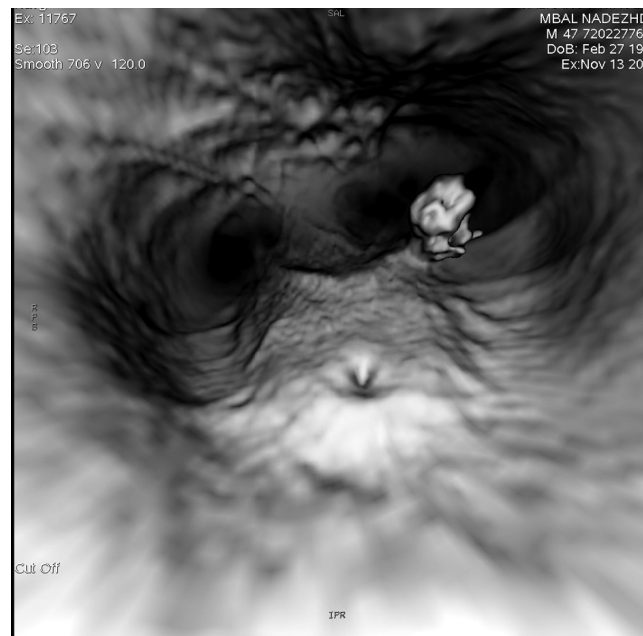


Fig. 4. Virtual cystoscopy during CT cystography

cystoscopy during retrograde CT cystography is a method with extremely high sensitivity and specificity allowing for reliable diagnosis of bladder cancer and follow-up after TURBT. There is no insufflation of air or other gas in the bladder and it can be applied in all cases where homogenization of contrast matter is necessary [1-3]. Hereby this methodology differs from the other techniques due to

its high diagnostic value and minimal invasiveness. Patient comfort is not altered, as in the case of virtual cystoscopy with gas insufflation [5,7]. The technique allows for a very high resolution and excellent post-processing capabilities compared to conventional computed tomography. It is the only method of choice in the absence of contrast matter secretion in the urinary tract in the course of a multiphase CT with virtual cystography. Compared to the axial CT and MRI examination of the pelvis, where the study takes a long time and depends on both the patient's compliance and the presence of blood in the bladder, assisted virtual cystoscopy during retrograde CT cystography is a much faster, more effective and more precise imaging method for assessment and diagnosis [5]. The results of several studies prove the high diagnostic value of the method for assessing localization, number and morphology of bladder masses [6,7].

In practice, this method is the ultimate imaging tool in patients with CKD or in the presence of other contraindications for the administration of contrast material intravenously (e.g. proven allergies to contrast agents), when it is necessary to clarify the condition of the bladder.

Conclusion. Assisted virtual cystoscopy during CT cystography is an imaging method with good diagnostic results in patients with CKD and hematuria of bladder origin. The clinical application of the method includes: primary diagnosis and follow up in patients with bladder cancer, differential diagnosis of hematuria of unknown origin, differentiation of prostate cancer and its relationship to the bladder wall. It is not included in the package of conventional computed tomography examination of the urinary system, but can be used to diagnose and monitor pathological processes as the results give high diagnostic value. In some cases, the test may be compromised by the patient's physical condition. With standardization of the method and, respectively, quality performance, its diagnostic value is very high.

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