Is there an advantage in performing a combined examination: diuretic renal scintigraphy and low dose computed tomography compared to the separate use of these methods in urolithiasis

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Abstract
Ultrasonography (US), radiography of the kidneys, ureters and bladder (RKUB), intravenous urography (IVU) and especially non-enchanced CT are well established diagnostic modalities in screening patients with urolithiasis, while not always fully diagnostic especially when obstructive uropathy or calculous pyelonephritis are present . Diuretic renal scintigraphy (DRS) can determine obstruction, may differentiate between complete or partial, acute or chronic obstruction, but can not specify the cause and often the location of obstruction. The imaging protocol, including DRS with technetium-99m-mercaptylacetyltriglycine (^{99m}Tc-MAG3) and single photon emission tomography/computed tomography (SPET/CT) of the kidneys, ureters, and urinary bladder allows for both functional and morphological information, visualization of renal stones and possible renal complications. The main advantages and limitations of this combined examination are discussed and the test is compared to the separate use of DRS and low dose of CT, in urolithiasis.

Introduction

Currently, ultrasonography (US), radiography of kidneys, ureters and bladder (RKUB) and intravenous urography (IVU) are widely used in screening patients with urolithiasis, while not always fully diagnostic especially when obstructive uropathy or calculous pyelonephritis exist [1-3]. Non-enhanced computed tomography (CT) is the standard of reference in the detection of urinary calculi due to its high sensitivity (95%-98%), specificity (98%-99%), and its ability to delineate and diagnose alternative causes of lower back pain [2-5]. However, even helical CT findings may fail to diagnose obstruction or its functional impact on renal parenchyma [6].

Dynamic diuretic renal scintigraphy with furosemide (DRS), although is most often indicated for the study of congenital or chronic renal obstruction, has not been used systematically for the evaluation of patients with renal colici [6]. Diuretic renal scintigraphy can determine the presence of obstruction and may differentiate between complete, severe or partial obstruction [6-8]. The reported positive predictive value (PPV) of DRS for the diagnosis of obstructive uropathy is up to 90.6% [9] compared to the PPV of non-enchanced CT, (of 56%) [6]. This test may also provide information about early parenchymal damage, acute or chronic obstruction [10]. However, DRS may not give specific information either about the cause and the exact location of renal obstruction. Therefore, a diagnostic test combining the advantages of morphological and functional modalities may be useful in every day clinical practice, in detecting urolithiasis and its complications.

The authors of this paper have experience in using a protocol for examining patients with urolithiasis which includes DRS with technetium-99m-mercaptylacetyltriglycine (^{99m}Tc-MAG3) and single photon emission tomography/computed tomography (SPET/CT) of kidneys, ureters, and urinary bladder [10, 11]. The patient is in the supine position and is injected with 74-185MBq of ^{99m}Tc-MAG3 and after 10min, with 20mg furosemide (F+10), followed by SPET/CT immediately after the end of the DRS. A circular orbit of 360 degrees, 64 projections, low dose CT protocol, with 110kV, 30mAs and slice thickness of 5mm was used. Results were interpreted visually except renal function, acquired by DRS, which was interpreted semi-quantitatively. Identification of urinary stones and indirect signs of obstruction like dilatation of the collecting system and/or perinephric fat stranding were evaluated by the low dose CT. The SPET scan supported the diagnosis of obstructive uropathy especially by identifying late retention of ^{99m}Tc-MAG3 in the collecting system, and revealed the level of obstruction by pro-

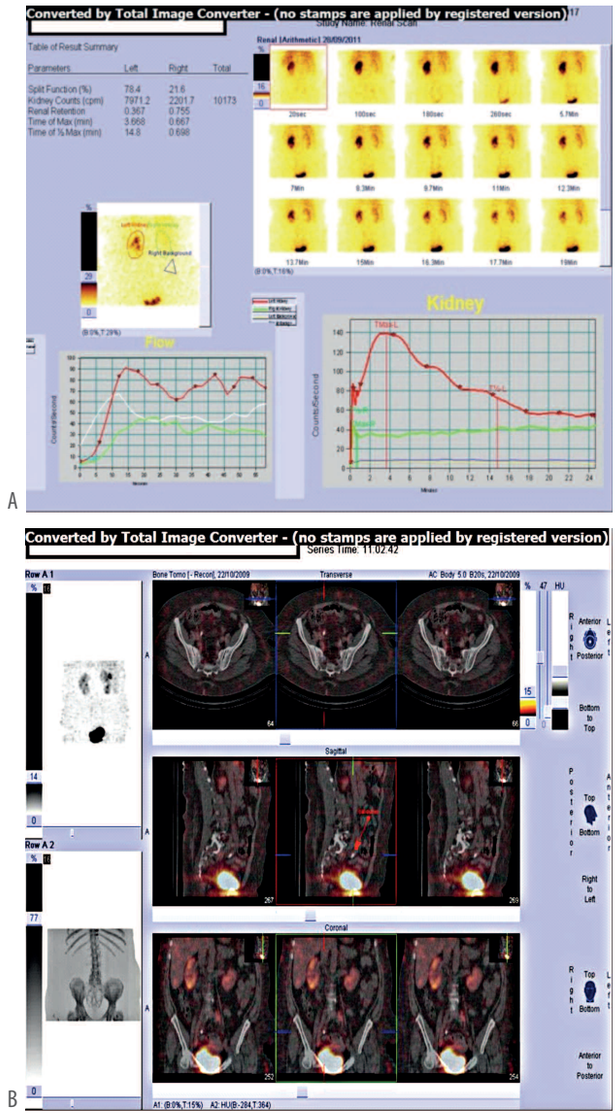

Figure 1. A 56 years old female with right lower back pain for 2 weeks. A: The DRS of the right kidney shows decreased and inhomogeneous uptake of the tracer in the renal parenchyma, "isosthenuric" type renogram (green line), split renal function: 21%. Left kidney shows normal renogram. B: SPET/CT: Right kidney shows late retention of the tracer in a dilated collecting system and a 9mm stone in the distal ureter. Left kidney shows normal findings.

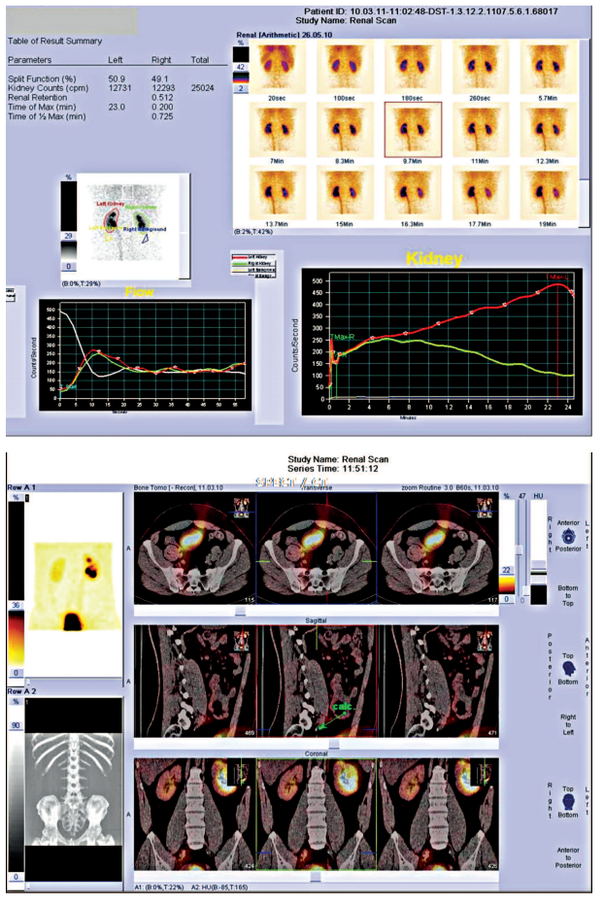

Figure 2. A 40 years old male patient with acute lower left lumbar pain lasting for 20 hours, with X-rays negative for urinary stones and no signs of hydronephrosis from US. A: The DRS of the left kidney shows homogeneous uptake of the tracer in renal parenchyma, hydronephrotic renogram (red line), without any change after diuretic stimulation. Normal renogram of the right kidney. B: SPET/CT: Left kidney shows delayed retention of the tracer in the non-dilated collecting system and 6mm stone in the distal left ureter, causing total obstruction. Right kidney: normal findings.

viding images with better quality than plannar scintigraphy. Thus, the same radiotracer injection provided additional diagnostic information.

The described imaging protocol (DRS, combined with SPET/CT) allows for not only functional, but also morphological information of renal stones and their exact location (Figures 1 A and B). In a recent study on 50 patients (100 kidneys) this combined study effectively identified the presence and cause of obstruction with sensitivity and specificity of 92% and 97%, respectively [12]. These findings are similar to those reported by other authors using only the low dose CT (95%-97% and 92%-97%) [4]. Of course, the low dose CT alone does not offer sufficient information about the functional status of renal parenchyma or the degree of obstruction. As indicated in our study, DRS diagnosed impaired drainage in 16 out of 42 kidneys (38%) which at first had been interpreted as normal by the low dose CT. Additionally, in 14 out of 22 kidneys (22%) with indirect signs of obstruction like dilatation of the collecting system and/or perinephric fat stranding on the CT images, DRS identified prolonged excretory phase, without functional evidence of obstruction. The estimated diagnostic accuracy for obstruction when using only the low dose CT was 80%, compared to 96% when the combined examination was applied [12].

Other studies have reported that DRS is indicated after a positive helical CT for urolithiasis in order to diagnose the degree of obstruction, detect spontaneous decompression, and stratify patients for emergency intervention, medical therapy or follow up [6, 7]. Other advantages of the DRS and low dose CT technique are that this technique is performed in a shorter period of time, which could be crucial, especially in a case of emergency (Figure 2 A and B) and that this technique in cases of calculous pyelonephritis can identify inhomogeneity, reduced thickness, and irregular outer kidney contours [12].

The effective dose for the combined technique is 2.0-3.0mSv [10], while for RKUB is 0.025-0.77mSv, for IVU is 5.4-

15.1mSv, for the low dose CT is 1.41-1.58mSv, for the unenhanced CT is 4.6-22.5mSv and for the CT-urography is 9.2-18.8mSv [13-16].

Limitations of the combined examination are the higher cost compared to renal scintigraphy or to low dose CT alone and the relatively limited availability of the hybrid SPET/CT scanners. Based on our experience, however, the overall cost/effectiveness of the proposed dual procedure, due to prompt diagnose making, compensates for its higher cost.

In conclusion, although the CT is the examination of choice for the diagnosis of urolithiasis, diuretic renal scinitgraphy combined with low dose CT may additionally show the degree of obstruction and of renal damage, can be applied in the emergency department and can be considered as cost-effective.

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