Impact of Gate 99mTc DTPA GFR, Serum Creatinine and Urea in Diagnosis of Patients with Chronic Kidney Failure

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ABSTRACT

Aim: The aim of this study was determination of validity of ^{99m}TcDTPA estimation of GFR for early detection of chronic kidney failure. **Material and methods.** There were 110 patients (54 males and 56 females) with kidney disease referred for evaluation of renal function at UCC of Kosovo. All patients were included in two groups. In the first group were included 30 patients confirmed with renal failure, whereas in the second group were included 80 patients with other renal disease. In study were included only patients with ready results of creatinine, urea and glucose in the blood serum. For estimation of GFR we have used the Gate GFR DTPA method. The statistical data processing was conducted using statistical methods such as arithmetic average, the student t-test, percentage or rate, sensitivity, specificity and accuracy of the test. **Results.** The average age of all patients was 36 years old. The average age of female was 37 whereas of male 35. Patients with renal failure was significantly older than patients with other renal disease ($p < 0.005$). Renal failure was found in 30 patients (27.27%). The concentration of urea and creatinine in blood serum of patients with renal failure were significantly higher than in patients with other renal disease ($P < 0.00001$). GFR in patients with renal failure were significantly lower than in patients with other renal disease, 51.75 ml/min ($p < 0.00001$). Sensitivity of uremia and creatininemia for detection of renal failure were 83.33%, whereas sensitivity of ^{99m}TcDTPA GFR was 100%. Specificity of uraemia and creatininemia were 63% whereas specificity of ^{99m}TcDTPA GFR was 47.5%. Diagnostic accuracy of blood urea and creatinine in detecting of renal failure were 69%, whereas diagnostic accuracy of ^{99m}TcDTPA GFR was 61.8%. **Conclusion:** Gate ^{99m}Tc DTPA scintigraphy in collaboration with biochemical tests are very sensitive methods for early detection of patients with chronic renal failure.

Key words: ^{99m}Tc DTPA-GFR, renal failure, creatinine, urea

1. INTRODUCTION

Renal diseases in people are major cause of morbidity and mortality (1). Renal disease can attack people at the childhood age, adults and old people at both genders (2).

Renal diseases, particularly chronic renal disease associated with end stage renal disease are global world problem and present major cause of morbidity and mortality (3, 4). Mortality caused by chronic kidney disease in the world has increased significantly and has increased from the 27th position in 1990 to 18th position in 2010 (5-8).

Currently worldwide are more than 2 million people who receive treatment in form of dialysis or a kidney transplant to stay alive, which present only 10% of people who actually need treatment to live (9). Chronic renal failure is the progressive loss of function of kidney and

patient requires a long treatment in the form of renal replacement therapy.

Patients with chronic renal failure usually have higher serum urea and creatinine levels, leading to various other dangerous diseases (10). In renal failure, especially in cases of chronic renal failure, was noted progressive decline of glomerular filtration rate followed with raising the level of creatinine and urea in serum (11).

Gate's glomerular filtration rate (gGFR) measured by ^{99m}Tc-DTPA renal dynamic imaging and estimated GFR (eGFR) estimated by the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation are two indexes used to evaluate renal function. However, little is known about whether gGFR can be used to accurately assess renal function in renal chronic failure, horseshoe kidney (HSK) patients with

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renal fusion anomalies, renal infection etc. (12). Determination of GFR by using renal dynamic imaging method with ^{99m}Tc -DTPA was performed for the first time at 1982. ^{99m}Tc DTPA is the most used radionuclide for determination of GFR because it was filtered by the glomeruli without tubular absorption (13).

2. MATERIAL AND METHODS

There were 110 patients (54 males and 56 females) with kidney disease referred for evaluation of renal function and pathophysiology to University Clinical Centre of Kosovo. Patients were included in two groups. In the first group were included 30 patients confirmed with diagnosis of renal failure, whereas in the second group were included 80 patients with other diagnosis of renal disease. Patients with incomplete biochemical analyzes (concentration of urea, creatinine and glucose in blood serum) are not involved in the study. Renal dynamic study with ^{99m}Tc DTPA was performed at all patients. All patients were instructed to drink water or juice 250-500 ml for hydration, usually 20-30 minutes prior to the examination. Young children and neonates were hydrated via intravenous administration of 250-300 ml 0.9% NaCl, 20-30 minutes prior to examination. The dynamic imaging was performed in the supine position at rate of acquisition of 1 frames/3 s for 1 minute and then one frame/20 s for 19 minutes, using a large field of view scintillation camera such that the kidneys and inferior border of the heart were included in the imaged field. The dynamic scintigraphy was performed at the time of intravenous administration of ^{99m}Tc DTPA bolus, with dose of activity 1-5 mCi. The radioactivity in syringe was measured before and after injection of radioactivity in patients. The total injected dose was determined by subtracting the post-count from the pre-count syringe activity. The region of interest (ROI) over each kidney is manually assigned on the composite image added from 2 to 3 min following injection, and the net count for each kidney is determined in the time interval from 2 to 3 min following the tracer arrival. GFR was automatically calculated by commercially available software according to the Gate's algorithm.

The statistical data processing was conducted using statistical methods such as arithmetic average, the student t-test, percentage or rate, sensitivity, specificity and accuracy of the test. The student t-test was used to compare the value of urea, creatinine and glucose in blood serum between two groups of patients included in study. The student t-test was used also to compare the value of GFR between two groups of patients (the difference is considered significant if the p value <0.05).

The sensitivity of the methods was defined by the formula: Sensitivity = $\text{TP} / (\text{TP} + \text{FN})$, the specificity of methods was defined by the formula: Specificity = $\text{TN} / (\text{TN} + \text{FP})$ and finally the accuracy of the test is defined by the formula: Accuracy = $(\text{TP} + \text{TN}) / (\text{TP} + \text{TN} + \text{FP} + \text{FN})$.

3. RESULTS

In this study were included 110 patients with renal disease, 54 (49%) males and 56 (51%) females. The average age of all patients was 36 year old. It was noticed no significant difference in average age between males and females ($p < 0.034$) (Table 1).

Gender	N	%	X
Male	54	49	35
Female	56	51	37
Total	110	100	36

Table 1. Presentation of data about gender and middle age of all patients

The t-value is 0.40879. The p-value is 0.0341775. The result is not significant at $p < .05$.

Of the total number of patients, 36 (32.27%) of them were younger than 12 while 74 (67.73%) were older than 12 years. The number of patients older than 12 years were significantly higher than number of patients younger than 12 years ($p < 0.00018$). In our study were included two groups of patients in study. The first group was consisted of 30 (46.63%) patients who had been diagnosed with chronic kidney failure while the second group was consisted of 80 (72.73%) patients with other renal diseases (Table 2). The average age of patients with chronic renal failure was 46.63 years, while the average age of patients with other kidney disease was 25.66 years. According to statistical criteria it is established that the difference of average age between the two groups of patients was significant ($p < 0.0001$) (Table 3).

Renal disease	N	%	X
Renal failure	30	27.27	46.63
Other renal disease	80	72.73	25.66
Total	110	100	36.14

Table 2. Patients with renal disease. The p value is 0.0001. The value is high significant at $p < p.05$

The average concentration of urea in the serum of patients with chronic renal failure was 12.7 mmol / L, while the concentration of urea in the serum of patients of the other group was 7.26 mmol / L. According to the statistical criteria, we found that the concentration of urea in the serum of patients with chronic renal insufficiency was significantly higher than in serum of the other group of patient's, $p < 0.00011$ (Table 3).

Renal disease/blood parameters	urea	creatinine	glucose
Renal failure	12.7	172.09	5.58
Other renal disease	7.26	92.85	6.69
Total	9.9	132.47	6.13

Table 3. Concentration of urea, creatine and glucose in blood serum. The p value is 0.00011. The value is high significant at $p < 0.05$

The average value of the concentration of creatinine in patients with chronic renal failure was 172.09 $\mu\text{mol/l}$ (normal value: 44-106 $\mu\text{mol/l}$), while the concentration of creatinine in the serum of patients of the other group was 26.7 $\mu\text{mol/l}$. According to statistical criteria, we found that the concentration of creatinine in the serum of patients with chronic renal insufficiency was significantly higher than in serum of the other group of patients $p < 0.000019$ (Table 3).

The average concentration of glucose in the serum of patients with chronic renal failure was 5.58 mmol / L, while the concentration of urea in the serum of patients of the other group was 6.7 mmol / L. According to statistical criteria, we found that the concentration of glucose in the serum of patients with chronic renal insufficiency was slightly lower than in serum of the other group of patients but the difference between two groups of patients was no significant $p < 0.1128$ (Table 3).

Evaluation of the glomerular filtration rate (GFR) at all patients included in the study showed that the average value of GFR was lower than the lower limit of normal value of GFR. The average value of GFR in all patients was 70.09 ml/per minute (normal = Low GFR 80 mL / min). GFR values in patients with kidney failure were significantly lower (51.75 ml/min) than in the group of patients with other kidney disease (88.84), $p < 0.00001$ (Table 4).

Renal disease	N	%	X
Renal failure	30	27.27	51.75
Other renal disease	80	72.73	88.84
Total	110	100	70.9

Table 4. The Value of GFR in renal disease. The p value is 0.00001.

The concentration of urea and creatine in blood serum of patients with renal failure were normal in 5 patients, while were elevated in 25 patients. The statistical calculation has confirmed that the specificity of the test of estimation of blood urea and creatinine for detection of chronic renal failure was 83.33% while the specificity of test was 63.75%. The accuracy of test was 69%. At all patients with chronic renal failure, the recorded values of GFR at Gate 99m Tc DTPA renal scintigraphy were lower, under 80ml/min. The sensitivity of this method for early detection of chronic kidney failure was 100%. Low values of GFR are also found in 42 patients in the second group without renal failure, therefore the specificity of the test was only 47.5%, and accuracy was 61.8 % (Figure 1).

Figure 1. Data of Gate 99m Tc DTPA GFR

4. DISCUSSION

Renal disease represent major problem in human health and can attack people at the childhood age, adults and old people at both genders (2).

Our study has confirmed these reported data from other authors because the renal diseases were found at all age groups and both gender. We found that 32% of our patients with renal disease were younger than 12 years and 68% were older than 12. The group of patients with renal failure was significantly older than group of patients with other renal disease ($p < 0.005$).

The best method for determination of GFR until now is inulin clearance. This method cannot be applied widely in clinical practice because of the technical complexity and nature of procedure. As only alternative to inulin clearance, in routine daily practice has been performed the intrinsic creatinine clearance (13).

The concentration of urea and creatinine in blood serum of our patients with renal failure were significantly higher than in patients with other renal disease ($P < 0.00001$). The concentration of glucose in blood serum of patients with renal failure was in range of normal values. By statistical criteria

there is no significant difference in blood concentration of glucose between two groups of patients ($p = 0.1$). We found that concentration of creatinine and urea in blood serum of patients with chronic renal failure was elevated in 25 patients whereas were normal in 5 patients. High value of creatinine and urea were noted also in blood serum of 29 patients without chronic renal failure but with other renal disease. The sensitivity and specificity of this test in early detection of chronic renal failure was 83.33%, respectively 63.75% while the Accuracy of these tests for early detection of chronic renal failure was 69%. We do not have found alteration of concentration of glucose in group of patients with chronic renal failure but in 15 cases with diabetes mellitus the concentration of blood glucose was elevated.

However this method is not accurate compared to inulin clearance so simple and accurate determination of the GFR is still a challenge in investigation (13).

Unlike biochemical methods, the value of GFR estimated with Gate ^{99m}Tc DTPA scintigraphy, was lower than minimal normal value in all patients with chronic renal failure. GFR in patients with renal failure were significantly lower than in group of patients with other renal disease 51.75 ml/min ($p < 0.00001$).

The sensitivity of this method for detection of chronic renal failure at early stage of disease was 100%. The low GFR was found also in 42 patients without renal chronic failure but with other renal disease. Unlike of the high sensitivity, the specificity of the method is significantly lower, only 47.5% due to the discovery of reduced GFR values in 42 patients without chronic kidney failure but other renal disease. The test accuracy was found to be 61.8%.

5. CONCLUSION

According of our data we concluded that Gate ^{99m}Tc DTPA scintigraphy in collaboration with biochemical tests are very sensitive methods for early detection of patients with chronic renal failure.

• Conflict of interest: none declared.

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