ORIGINAL ARTICLE

EFFECT OF OUTFLOW OBSTRUCTION ON THE RELATIVE RENAL FUNCTION ESTIMATION WITH ^{99M}TC-MAG-3 AND ^{99M}TC-DMSA

Zareen Aijaz Ghouri,[1] Akhtar Ahmed,[1,2] Naureen Nizar,[1]

[1] Department of Nuclear Medicine, Sindh Institute of Urology and Transplantation (SIUT), Karachi, Pakistan
[2] Karachi Institute of Radiotherapy and Nuclear Medicine (KIRAN), Karachi, Pakistan

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ABSTRACT

BACKGROUND: Several areas of controversy still exist in the selective preference of the method for estimation of relative renal function in patients with outflow obstruction. **OBJECTIVES:** The aim of this study was to compare the estimation of relative renal function by ^{99m}Tc-MAG-3 and ^{99m}Tc-DMSA in patients with unilateral outflow obstruction. **METHODS:** ^{99m}Tc-DMSA scintigraphy was done on 34 patients with outflow obstruction on ^{99m}Tc-MAG3 scintigraphy. Relative renal functions were calculated and effect of obstruction on the relative renal function was compared. **RESULTS:** Good correlation was observed in the estimation of relative renal function estimated by both the methods. One third of the patients had overestimated renal function on ^{99m}Tc-DMSA scintigraphy, however the difference was not statistically significant. **CONCLUSION:** Although ^{99m}Tc-DMSA and ^{99m}Tc-MAG3 relative renal function estimation show a statistically significant correlation, the over estimations of relative renal function by ^{99m}Tc-DMSA in a significant number of case with outflow obstruction needs further clarification.

Key words: DMSA, MAG3, Relative Renal Function, Renal Outflow Obstruction

Introduction

Differential renal function studies provide information of critical importance in the diagnostic and prognostic evaluation of patients with outflow obstruction. Deterioration of the relative renal function depends on the degree of obstruction but improves after the removal of cause. Baseline relative renal function is an important prognostic factor in the management of outflow obstruction. Improvement may not be observed especially in patients with relative renal function of affected kidney is less than 30%.[1]

Technetium-99m-mercaptoacetyltriglycine (^{99m}Tc-MAG3) is a renal plasma flow agent excreted by tubular secretion in proximal tubules and provides information about perfusion, uptake and drainage of tracer from kidney. Technetium-99m-dimercaptosuccinic acid (^{99m}Tc-DMSA) is taken up by proximal and distal renal tubular cells and is used for cortical imaging. It provides information about renal size, evidence of hydronephrosis and cortical scarring.

Relative renal function can either be measured by using dynamic renal scintigraphy with tubular agent ^{99m}Tc-MAG-3 or static cortical scintigraphy with ^{99m}Tc-DMSA.

In ^{99m}Tc-MAG3 studies relative renal function is calculated using the arithmetic mean with images acquired in the posterior position and in ^{99m}Tc-DMSA studies relative renal function is calculated using the geometric mean and taking kidney depth into account by acquiring images both anterior and posterior projections. Consensus statements have been formulated in an attempt to standardize methods of performing these investigations.[2,3] However, several areas of controversy still exist in the selective preference of individual study in different clinical settings. The aim of this study was to compare the estimation of relative renal function by ^{99m}Tc-MAG-3 and ^{99m}Tc-DMSA in patients with unilateral outflow obstruction.

Correspondence : Dr. Naureen Nizar
Department of Nuclear Medicine
Sindh Institute of Urology and Transplantation
Karachi, Pakistan Tel: 99215752 Ext: 2230
Email: naureennizar@hotmail.com

Materials and Methods

We prospectively recruited 34 patients with diagnosis of unilateral hydronephrosis on ^{99m}Tc-MAG3 scans and carried ^{99m}Tc-DMSA scans on these subjects within one week of the ^{99m}TC-MAG3 scans. Dynamic study was acquired after intravenous injection of 111-148 MBq of ^{99m}Tc-MAG3. The dose for children was scaled according to age. Images were acquired using Large field of view gamma camera (GE Infinia) equipped with low energy general purpose collimator. 20% symmetric window was set around 140 keV photopeak energy. Diuresis (Inj Frusemide 1 mg/kg, maximum dose 40 mg) was given at the start of the study (F+0 Protocol).[4] Initial 30 frames of 2 seconds each were acquired followed by 96 frames of 15 seconds each. DMSA scan was performed 3-4 hours after the intravenous injection of ^{99m}Tc DMSA. The mean dose of administered activity was 104 MBq . Posterior, Anterior, Right and Left anterior oblique and right and left posterior oblique planar images were acquired. A total of 700K counts were acquired per view in 256x256 matrix. The data was analyzed on GE Infinia Xeleris software (Fig.1).

Correlations between ^{99m}Tc-MAG3 and ^{99m}Tc-DMSA relative renal function values were calculated by Pearson correlation. The means were analyzed using simple box plots and the means were compared using paired student T test. P values <0.05 were accepted as statistically significant.

Results

During the four month study period static renal scintigraphy with ^{99m}Tc-DMSA was performed in 34 consecutive patients with unilateral hydronephrosis on ^{99m}Tc-MAG-3 within one week of scan. The mean age of the study population at the time of scans was 28.61 years (SD ± 12.86 years and range 8-62 years). For the whole study group mean relative renal function for the left kidney was 51.27±19.33 percent on ^{99m}Tc-MAG-3 (range 19-83 percent) and 50.17±16.06 on ^{99m}Tc-DMSA (range18.5-74 percent) and mean relative renal function for the right kidney was 48.69±19.31 percent on ^{99m}Tc-MAG-3 (range 16.5-81 percent) and 49.83±16.04 on 99mTc-DMSA (range 25.8-81.5 percent).

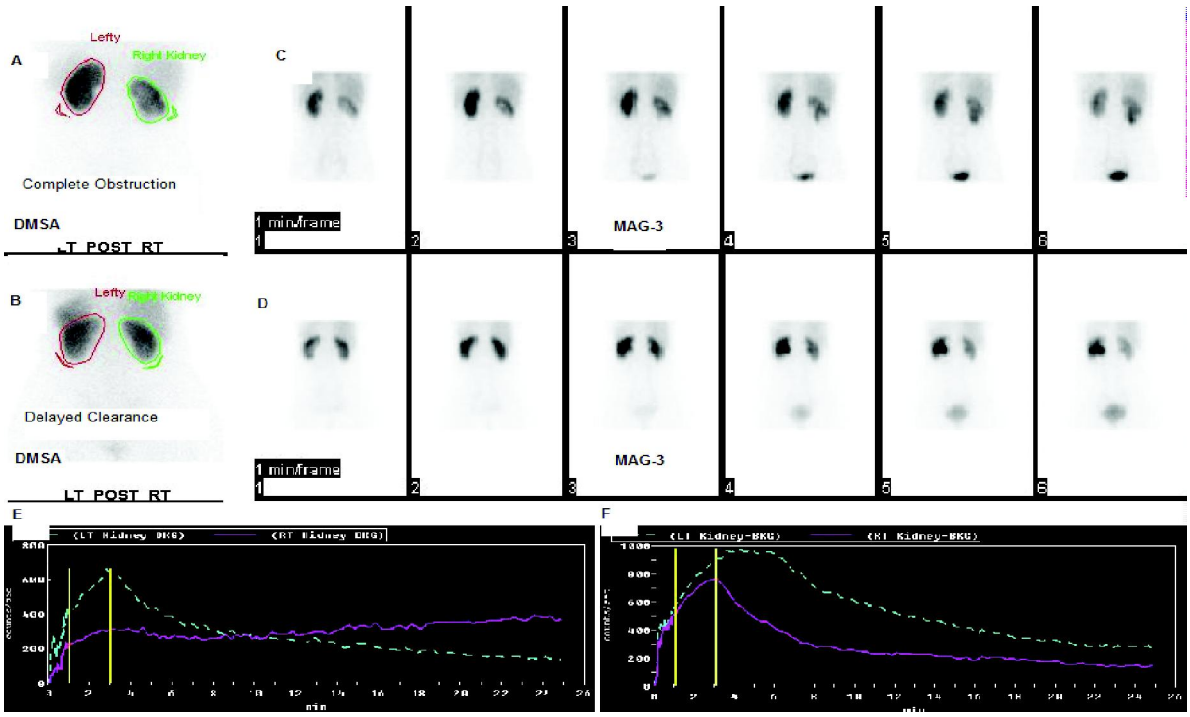

Figure-1: A. DMSA renal scan in patient with complete outflow obstruction of right kidney. B. DMSA renal scan in patient with delayed outflow clearance from left kidney. C. MAG3 renal scan in patient with complete outflow obstruction of right kidney. D. MAG3 renal scan in patient with delayed outflow clearance from left kidney. E. Renogram curve of patient with complete outflow obstruction of right kidney. F. Renogram curve of patient with delayed outflow clearance from left kidney

Left kidney was affected in 17 cases (50%) and also right kidney was affected in similar number of cases. The mean relative renal function for the affected kidney was 33.70±10.1 percent on ^{99m}Tc-MAG-3 (range 16.5-52.8 percent) and 37.7±10.07 on 99mTc-DMSA (range18.52-53.80 percent) (Fig.2). The difference was statistically significant (p<0.01).

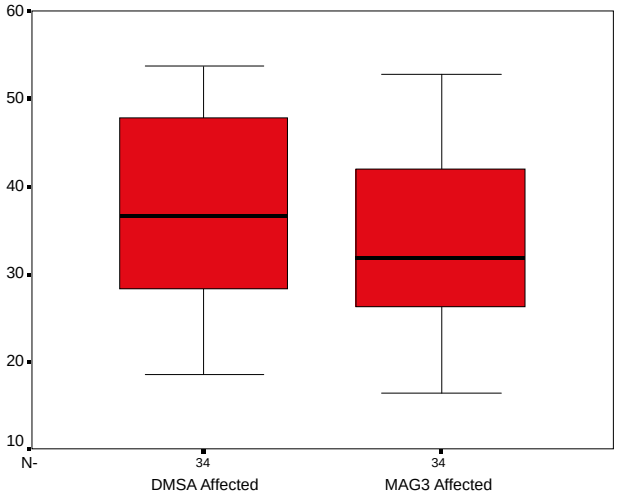

Figure 2: Mean relative renal function values of the affected kidney on DMSA and MAG3 scan.

There was significant correlations between the ^{99m}Tc-MAG3 and ^{99m}Tc-DMSA relative renal function in the affected kidney (p<0.01 Pearson correlation 0.90). (Fig.3) No improvement was observed if the scans were classified as normal (≥45%) and abnormal (<45%) according to relative renal function.

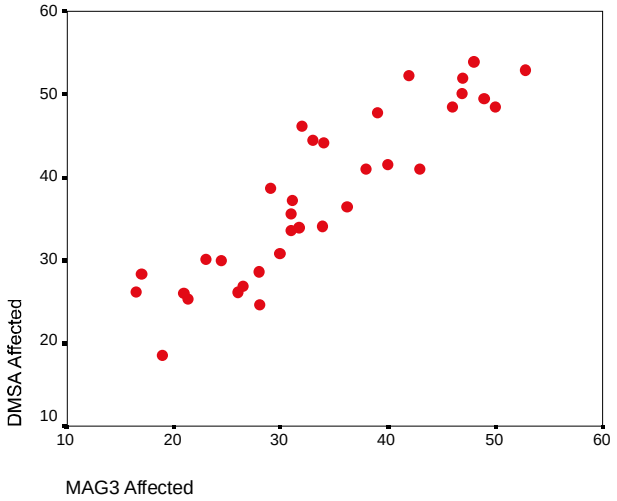

Figure 3: Correlation of the relative renal function of the affected kidney on DMSA and MAG3 scan.

The mean difference between the relative renal function of the affected kidney by ^{99m}Tc-DMSA and ^{99m}Tc-MAG3 was 4.43±4.01 (range 0.01 – 14.06). The mean difference was 4.15±3.81 if the scans were classified as normal (≥45%) and 5.11±4.59 if the scan were classified as abnormal (<45%) according to relative renal function. The difference between the two groups was insignificant.

If difference of ≥5% was taken as of clinical significance, ^{99m}Tc-DMSA overestimated relative renal function in one third of cases (11 out of 34). The overestimation was noted in 10 of the 24 cases with outflow obstruction as demonstrated on ^{99m}Tc-MAG3 renogram and in one of the 10 cases with non-obstructed kidneys on renogram.

Discussion

Dynamic and static renal scintigraphy are utilized for baseline, post-operative and follow-up assessment of renal function. The results of these methods are accurate and good correlation is observed among the methods. However distinct biological properties of radiopharmaceuticals like mechanism of renal excretion, renal cell retention, plasma protein binding and plasma clearance result is slight variation in results. A good correlation has been observed in the estimation of relative renal function of the affected kidney by both dynamic and static renal scintigraphy has been demonstrated in this study which correlates with the findings of Aktas GE et al.[5]

Lythgoe MF et al.[6] in a small study of 20 children with normal renal function showed similar relative renal functions values, irrespective of the method and analysis technique used undergoing 99mTc-MAG3 and ^{99m}Tc-DMSA scans. Bair et al.[7] found good correlation of relative renal function calculated from ^{99m}Tc-DMSA and ^{99m}Tc-MAG3 scans in a total of 37 patients. In another of 59 children with previous UTI undergoing ^{99m}Tc-MAG3 and ^{99m}TC-DMSA scans close correlation was observed in the relative renal function values.

The findings of this study also reveal a close correlation between the relative renal function calculated using ^{99m}Tc-DMSA and that calculated using ^{99m}Tc-MAG3 renography in the whole group of patients. There was some evidence that as the kidneys became obstructed

a difference between the relative renal function values is observed (DMSA>MAG3) but the mean difference was 4.43, well within what we thought was a clinically acceptable range.[8] These observation correlate with a retrospective study of 92 children by Ritchie G et al.[9]

^{99m}Tc-DMSA overestimated the relative renal function in obstructed kidney as compared to non-obstructed kidney. The mean difference between the two methods was statistically significant for obstructed and non-obstructed kidneys.

The possible explanation for overestimation of relative renal function by ^{99m}Tc-DMSA is that up to 10% of the activity may be excreted into the urine. In an obstructed kidney this activity will be retained in the kidney area and counted, leading to overestimation of the function of that kidney. Free technetium either from the injection or liberated in vivo can also add inaccuracy in the estimation of relative renal function on ^{99m}Tc-DMSA studies.

Conclusion

Although ^{99m}Tc-DMSA and ^{99m}Tc-MAG3 relative renal function estimation show a statistically significant correlation, the over estimations of relative renal function by ^{99m}Tc-DMSA in a significant number of case with outflow obstruction needs further clarification.

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