Original Article

Correlation between glomerular filtration rate with gamma camera and estimated serum creatinine clearance from Cockcroft and Gault's formula

Shivanand Bhushan, Rajesh Kumar[1]

Department of Nuclear Medicine, MCOAHS, Manipal, [1]JIPMER, Puducherry, India

ABSTRACT

Purpose of the Study: The purpose of the present study is to find out the correlation between the glomerular filtration rate (GFR by Gates gamma camera method) and serum creatinine clearance (SCrCl by Cockcroft and Gault's method) within ± 3 weeks' time difference. **Materials and Methods:** Study design retrospectively in 59 patients with serum creatinine value calculated for SCrCl with Cockcroft and Gault's formula as an index parameter for kidney function underwent the 99m-Technitium labeled Di-ethyl Triamine Penta Acetic Acid (99mTc-DTPA) renogram with ECIL planar gamma camera. **Results:** All data of 59 patients has been divided into Group- I, II, and III based on the time difference of serum creatinine test from 99mTc-DTPA renal GFR tests performed on the same subjects. Serum Creatinine test was carried out within ± 3 days, between ± 4 days and ± 7 days, and between ± 8 days and ± 21 days from the DTPA GFR Test performed in the Group-I, II, and III respectively. Correlation coefficient of Group-I (n = 15) patients showed 0.8198 and P value < 0.001 for GFR and S. Creatinine within ± 3 days. Group-II (n = 17) and Group-III (n = 27) patients having correlation coefficient 0.6194 and 0.589 and P value <0.01 respectively, within ± 21 days. The two methods gave almost identical estimate of GFR even at 3 weeks interval. **Conclusions:** Study concludes that SCrCl using Cockcroft and Gault's formula could serve as an instant, easy, and reliable method for assessing kidney function. SCrCl with Cockcroft and Gault's formula is more useful for rapid estimation of global GFR for those patients who are not accessible to DTPA renogram with gamma camera. Correlation can be established further with the prospective study in various renal pathophysiological conditions.

Keywords: 99m-Technitium labeled Di-ethyl Triamine Penta Acetic acid, renogram, cockcroft and Gault formula, gamma camera, glomerular filtration rate, serum creatinine clearance

INTRODUCTION

Various methods have been developed for the assessment of kidney function. Every method has its own limitations. The measurement of Glomerular filtration rate (GFR) is based on the concept of clearance[1] through the kidneys. Urea, insulin, and creatinine clearance (CrCl) tests are used to examine impairment of glomerular filtration. Although, inulin clearance is considered as gold standard but this method is impractical for routine use due to cumbersome methodology. 99m-Technitium labeled Di-ethyl Triamine Penta Acetic acid (Tc99m-DTPA) clearance as renogram with the gamma camera method is much simpler and popular in routine clinical practice compared to plasma sampling method to measurement of GFR. Gamma camera Di-ethyl Triamine Penta Acetic Acid (DTPA) renogram provides GFR[2,3] to know the split kidney function as well.

At the same time estimated Serum creatinine clearance (SCrCl)[4] with the Cockcroft and Gault's formula is simple and easy to know the instant global kidney function. Taking various logistics into account serum creatinine although, is not an ideal filtration marker, however, its clearance may be regarded as standard for overall kidney function evaluation[5] specially, in the regions where radionuclide facility is limited and/or patient cannot afford the DTPA renogram. The estimated CrCl is the choice of investigation for assessing the functional status of kidneys. In this present study, it has been tried to establish the validity of estimated SCrCl from serum creatinine using Cockcroft

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Address for correspondence:
Dr. Shivanand Bhushan, Assistant Professor-Sr. Scale, Department of Nuclear Medicine of MCOAHS, Kasturba Hospital, Manipal University, Manipal - 576 104, Karnataka, India. E-mail: drshivanandbhushan@gmail.com

and Gault's formula in relation to GFR measured by using radionuclide gamma camera method as a marker of renal dysfunction.

MATERIALS AND METHODS

All the data of patients in the present retrospective study was collected from nuclear medicine record room data includes serum creatinine levels and the value of GFR by gamma camera method of the same patient with the time line. Freeze dried DTPA kit (TCK-7) procured from board of radiation and isotope technology was labeled by adding 50-60 mCi in 3-4 ml of Technetium-99m sodium pertechnetate following manufacturer's protocol. Planar gamma camera (ECIL, Hyderabad) fitted with low energy all purpose (LEAP) collimator was used to measure GFR of all the patients. Fifty nine patients of age between 5 years and 55 years were selected and CrCl was calculated using the formula of CG. Then the CrCl was normalized to a standard body surface area of 1.73 m^2. In adult patient, generally, 3-4 mCi Tc99m-DTPA is administered intravenously through bolus injection. Injection and data acquisition is started simultaneously and the data is acquired in frame mode. The four frames between 120 s and 180 s were added to form a composite image of 2-3 min. Regions of interest were drawn around each kidney while background region was drawn lateral to each kidney.

The GFR is calculated using gate's formula in renal software. Patient height (in cm) weight (in kg), age (in years) and sex are fed as input according to the program. Now percentage of injected dose (% ID) is calculated for each kidney.

$$\%ID = \frac{(K-B)\times 100}{I\times S\times D}$$

Where, % ID = Percentage injected dose
I = Injected activity (in MBq)
S = Camera sensitivity (in Cts/min/MBq)
K = Kidney region (Cts/min)
B = Background region (Cts/min)
D = Depth correction
GFR is calculated from Gates formula
GFR (ml/min/1.73 Sqm) = (% ID left + % ID right) × 9.8127 − 6.8252

RESULTS

All data has been divided into three groups based on the time difference between the Serum Creatinine test and 99mTc-DTPA renal GFR tests performed on the same subjects.

- Group-I (*n* = 15 subjects) consists serum creatinine tests performed within ± 3 days from DTPA GFR test.
- Group-II (*n* = 17 subjects) consists serum creatinine test performed within ± 4-7 days from DTPA GFR test.
- Group-III (*n* = 27 patients) serum creatinine tests performed within ± 8-21 days from DTPA GFR test.

The detailed results have been depicted in Tables 1-3. The correlation coefficient of Group-I (r_1) is obtained 0.8198 and *P* value is < 0.001. Therefore, significant level is 99.9%. The correlation coefficient of Group-II (r_2) is found 0.6199 and *P* value is < 0.01 and significant level is 99%. The correlation coefficient of Group-III (r_3) is observed 0.5894 and *P* value is < 0.01 and significant level is up to 99%.

DISCUSSION

SCrCl by Cockcroft and Gault's formula shows close correlation between GFR measured by 99mTc-DTPA using scintigraphy. Statistical analysis of the three groups reveals that the value of correlation coefficient of Group-I is more than that of the Group-II and that of Group-II is more than Group-III. The serum creatinine also holds well with probability of occurrence of the Correlation coefficients i.e., *P* value. The data shows that the level of significance of Group-I is much more than that of Group-II and III. This implies than more nearly the time of

Table 1: Comparison of serum creatinine clearance and glomerular filtration rate measurement performed between 3 days

Patient no.	Age/sex (years)	Wt/Ht (kg/cm)	S. Creatinin (mg/dl)	S. Creatinin clearance (ml/min/1.73 m^2)	Gates GFR (ml/min/1.73 m^2)
01	30/M	42/153	0.8	103.55	48.00
02	6/M	15/107	0.5	144.16	81.00
03	40/F	62/147	0.8	99.55	25.21
04	18/M	41/147	3.3	28.23	21.12
05	30/M	52/156	0.9	101.80	54.52
06	18/F	50/149	0.5	173.04	60.31
07	15/M	49/150	0.7	147.03	57.14
08	45/M	59/158	1.7	49.20	25.11
09	7/M	24/122	1.0	85.21	35.30
10	15/M	52/150	3.4	31.25	19.96
11	16/F	52/152	0.9	98.87	49.38
12	8/M	18/116	0.5	150.24	94.14
13	40/M	52/172	0.9	87.87	61.97
14	35/M	50/165	3.18	26.27	24.56
15	25/M	45/142	1.0	93.48	47.99

GFR: Glomerular filtration rate, S. Creatinine: Serum creatinine, No.of patients *n*=15, *r*1=0.8198, *P* value<<0.001, Significant level=99.9%

Table 2: Comparison of serum creatinine clearance and glomerular filtration rate measurement performed between 7 days

Patient no.	Age/sex (years)	Wt/Ht (kg/cm)	S. Creatinin (mg/dl)	S. Creatinin clearance (ml/min/1.73 m²)	Gates GFR (ml/min/1.73 m²)
01	30/F	85/155	1.3	61.72	31.00
02	19/M	67/165	0.8	139.14	67.36
03	7/M	15/103	1.1	66.03	42.80
04	38/F	42/146	1.1	61.19	56.02
05	37/F	73/141	0.6	151.44	63.44
06	19/M	73/175	1.4	80.64	70.86
07	33/F	46/140	1.2	62.51	51.02
08	24/F	48/145	0.8	102.27	62.06
09	52/M	45/155	1.6	42.79	38.65
10	45/M	64/165	0.8	106.80	53.88
11	22/M	52/160	1.10	88.17	57.29
12	28/F	49/145	0.9	88.96	59.52
13	23/M	47/157	2.9	31.87	19.81
14	12/M	29/130	0.5	174.88	56.27
15	36/M	54/157	2.5	35.28	22.00
16	12/M	32/135	1.0	90.29	82.03
17	15/M	45/152	0.9	103.83	52.12

GFR: Glomerular filtration rate, S. Creatinine: Serum creatinine, n=17, r_2=0.6199, P value<0.01, Significant level 99%

Table 3: Comparison of serum creatinine clearance and glomerular filtration rate measurement performed between 21 days

Patient no.	Age/sex (years)	Wt/Ht (kg/cm)	S. Creatinin (mg/dl)	S. Creatinin clearance (ml/min/1.73 m²)	Gates GFR (ml/min/1.73 m²)
01	26/M	60/170	1.0	97.83	47.46
02	50/F	33/145	0.7	75.35	54.00
03	30/M	69/170	2.8	36.20	64.37
04	50/M	62/162	0.5	160.57	49.91
05	40/F	36/146	1.8	33.76	33.80
06	35/F	45/143	0.5	144.03	49.12
07	10/M	22/120	0.7	114.16	91.18
08	10/F	22/126	0.5	132.76	82.00
09	27/M	52/155	1.2	78.44	41.52
10	20/M	50/170	0.8	117.02	67.94
11	26/M	45/165	3.3	25.94	15.33
12	27/M	55/170	1.0	92.75	24.49
13	18/M	47/163	1.1	85.79	63.64
14	37/M	54/160	3.0	28.74	39.10
15	13/M	25.5/13	1.3	61.08	60.65
16	26/M	55/156	0.5	195.66	69.58
17	12/M	32/140	0.5	175.75	69.28
18	21/M	58/170	0.7	143.58	81.85
19	10/M	23/120	0.5	165.16	70.89
20	28/M	65/172	1.2	82.82	47.24
21	10/M	24/125	1.6	51.48	28.70
22	8/F	24/122	0.5	143.78	65.75
23	52/M	62/155	1.85	43.47	43.21
24	28/F	38/145	0.5	140.20	41.14
25	15/M	42/152	1.0	94.85	67.42
26	25/F	35/140	1.07	65.67	48.83
27	32/M	50/160	1.9	45.83	25.75

GFR: Glomerular filtration rate, S. Creatinine: Serum creatinine, n=27, r3=0.5894, P value <0.01, Significant level 99%

measurements of serum creatinine level to the measurement of GFR of the patient, more is the value of correlation coefficients. Probably disease associated with patient may be one of the factors of different in the value of correlation coefficient that means disease would have been progressing during that time interval and i.e., why poor correlation in Group-II have been obtained.

Since, the present study is of retrospective nature, it is obvious to have some drawback. It would be better to conduct a prospective study disease wise. Their good correlation may exist in the three groups. Each indicates that serum creatinine may be a tool for the evaluation of kidney functions where nuclear medicine facilities are not commonly available. There is less number of specialized health center as well as limited resources for such a large population. Quick decision to see a kidney functional status of patient is required. In such situation, SCrCl using Cockcroft and Gault's formula may serve the purpose because this method has proven accuracy and is easier to perform than any other method of kidney function

evaluation. SCrCl value and gamma camera method GFR on the same patient can be complementary for assessing any instrumental error incurred to check quality performance of gamma camera; if any; to both nuclear physicians and quality control managers in nuclear medicine. On the other hand, GFR measured by 99mTc-DTPA scintigraphy[6,7] is also significant because of its accuracy and reproducibility of the measurement being very high. It is a fast and easy method being computerized and through this method differential kidney GFR can be determined.

REFERENCES

1. Waller DG, Keast CM, Fleming JS, Ackery DM. Measurement of glomerular filtration rate with technetium-99mDTPA: Comparison of plasma clearance techniques. J Nucl Med 1987;28:372-7.
2. Keopke, John A, Keopke, John F. Guide to clinical laboratory diagnosis. 3rd ed. US California: Appleton and Lange; 1987. p. 40-56.
3. Gates GF. Creatinine clearance estimation from Serum creatinine values: An analysis of three mathematical model of Glomerular function. Am J Kidney Dis 1985;3:199-205.
4. Trollfors B, Alestig K, Jagenburg R. Prediction of glomerular filtration rate from serum creatinine, age, sex and body weight. Acta Med Scand 1987;221:495-8.
5. Perrone RD, Madias NE, Levey AS. Serum creatinine as an index of renal function: New insights into old concepts. Clin Chem 1992;38:1933-53.
6. Braren V, Versage PN, Touya JJ, Brill AB, Goddard J, Rhamy RK. Radioisotopic determination of glomerular filtration rate. J Urol 1979;121:145-7.
7. Klopper JF, Hauser W, Atkins HL, Eckelman WC, Richards P. Evaluation of 99mTc-DTPA for the measurement of glomerular filtration rate. J Nucl Med 1972;13:107-10.

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