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A Comparison of GFR by Cockcroft-Gault Equations and Gates method for estimating Glomerular Filtration Rate in Chronic Kidney Disease Patients.

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***ABSTRACT**: The gamma camera uptake method with 99m Technetium labeled Diethylene Triamine Penta Acetic acid (Tc-DTPA) is simple and less time consuming for determination of glomerular filtration rate (GFR). Predicted creatinine clearance methods were compared with Gates method using 99m Tc-DTPA for measurement of GFR.99mTc-DTPA renography was performed on 92 patients (72 men and 20 women, age range being 21 to 72 years) with wide range of renal function. The GFR was determined simultaneously by two methods,(a)Gamma camera uptake (Gates),(b)Predicted creatinine clearance methods: (i) Cockcroft-Gault (CG) and (ii) Modification of Diet in Renal Disease (MDRD). The Gamma camera uptake method was chosen as a reference. For GFR <15ml/min/1.73m2, there were no formulae correlated with isotopic GFR (iGFR). The MDRD equation was found to correlated with iGFR when GFR ranges16-29 ml/min/1.73m2 (P=0.0004) and GFR ranged from 30-59 ml/min/1.73m2 (P=0.0001). The CG formula was correlated with iGFR (P=0.0172) when GFR ranges from 60-89 ml/min/1.73m2.CG estimate of GFR predicts renal function in patients with chronic kidney disease (CKD) in normal GFR range (>60 ml/min/1.73m2). The MDRD equation estimated that the GFR predicts renal function in patients with CKD when GFR range from (16 to 60 ml/min/1.73m2). There are no formulae that predicts GFR<15 ml/min/1.73m2.*

***KEY WORDS:** Glomerular Filtration Rate, 99mTc-DTPA, Cockcroft-Gault's equation, MDRD.*

I. INTRODUCTION

Measuring GFR is widely accepted as the best index of kidney function. [1, 2] The most common method for accessing GFR in the past was performing a urine creatinine clearance which might give inaccurate result as a result of improper collection and over estimation of GFR due to kidney tubular secretion of creatinine .[2]
Inulin clearance is used as standard for determination of GFR but this method is not performed in clinical practice, because of technical complexity .99mTc-DTPA renography introduced by Gates [3] has been most common as a routine method. There is a debate whether the gates method is accurate for predicting the GFR [4-12]. 99mTc-DTPA renography is more accurate than 24 hours Creatinine clearance and is acceptable for clinical use in patients with reduced renal function [13]. In 99mTc-DTPA renography, the GFR is calculated without any blood /urine sampling [14]. The two most commonly used equation methods are the Cockcroft-Gault (CG) [16,.] and Modification of Diet in Renal Disease(MDRD)formula [15].So, we estimated the GFR by these 2 methods and also by Gates method and compared them to find out any correlation between the 2 methods .

II. MATERIALS AND METHODS

Subjects 92 subjects (72 men and 20 women) ranging in age from 21 to 72 were included in the study.
The subjects were referred for evaluation of renal function in routine nephrology practice. The subjects belonged to a wide variety of clinical diagnosis including chronic glomerular nephritis (46 patients), diabetic nephropathy (18 patients), chronic tubular interstitial nephritis (24 patients), bilateral hydronephrosis in 4 patients, analgesic nephropathy in 2 patients. Informed consent was obtained prior to the test. The patients are made to lie down on a bed in the supine position. 99mTc-DTPA was injected through an indwelling butterfly needle in an anticubital vein and was followed by infusion of 20 ml of normal saline. Frames of 128 x 128 matrix were recorded with an online computer, initially at one second for one minute again at 10 seconds for 20 minutes. Region of interest (ROI) over each kidney was assigned manually on the frame added from 1 to 3 minutes following injection. The semi lunar background ROI around each kidney was defined and was modified for the inferior ROI's in the original gates. The background corrected time-activity curve was generated and the renal update of individual kidney for one minute from 2 to 3 minutes after the injection was calculated. The GFR was automatically estimated by a commercially available computer programme (E.CAM,Siemens, USA) according to the Gate's algorithm. The GFR was also predicted from the serum creatinine level at renography using CG and MDRD equations.

CG METHOD

$$GFR(ml/min) = \frac{(140 - age)\,Weight\ (kg)}{72 \times S.Cr\ (mg/dl)}$$

For women, multiply with 0.85.

MDRD METHOD

$$GFR(ml/min) = 186 \times (S.Cr\ in\ mg/dl)^{-1.54} \times age^{-0.203}$$

For women, multiply with 0.742.

The serum creatinine was measured by autoanalyser with modified Jaffe's method.
The GFR (ml/min) is obtained by the above two methods normalized for a body surface area of $1.73m^2$ [17].
Values are given as mean ± standard deviation. The association between isotopic GFR and estimated GFR was assessed by multiple regression analysis. $P < 0.05$ was taken as a significant value.
A total 92(72 men and 20 women) were divided in to four stages based on iGFR levels as follows :

Table: 1:

GFR($ml/min/1.73m^2$)	No. of patients
<15	15
16-29	30
30-59	36
60-89	11

Both CG (=0.0854) and MDRD equation (=0.6314) did not correlate with isotopic GFR when GFR was <15 ml/min/1.73m2.

Table: 2:

GFR($ml/min/1.73m^2$)	P Value	
<15	0.6520	
16-29	0.0004	
30-59	0.0001	
60-89	0.0172	

The MDRD equation was correlated with iGFR when GFR ranges from 16-29 ml/min/1.73m2 (=0.0004) and 30-59 ml/min/1.73m2 (=0.0001). CG formula was correlated with iGFR (=0.0172) when GFR was 60-89 ml/min/1.73m2.

Table 3: Correlation of isotopic GFR (iGFR) with estimated GFR (eGFR) by using CG and MDRD formula.
* Statistically significant: NS- statistically not significant.

GFR, ml/min/1.73m2	n	iGFR	CG	MDRD	*P* value
<15-20	15	10.90± 2.50	16.40±10.74	14.06±8.80	NS

16-29	30	22.50±4.44	24.46±17.88	20.49±15.90	0.0004*
30-59	36	38.90±4.6	40.04±26.10	35.23±18.92*	0.0001*
60-89	11	67.40±7.81	65.99±23.22	60.91±20.70	0.016 *

III. DISCUSSION

The MDRD and CG equations are the most widely recommended and used formulae for assessment of renal clearance, and hence this discussion focuses primarily on these two equations. Our first observation is that the MDRD and CG equations perform much more poorly in subjects with end stage renal disease (GFR<15 ml/min/1.73m2) compared with GFR estimation 99mTc-DTPA renal scan- Gates method. Also, the MDRD prediction equation performs well in subjects with moderate and severe renal disease (GFR 16-59 ml/min/1.73m2) in our study. Some other studies have confirmed our findings that the MDRD equation shows generally greater precision and accuracy than the CG formula in patients with CKD (GFR< 60 ml/min/1.73m2) .Finally, we have observed that the CG formula estimates GFR well in subjects with normal or mild CKD (GFR>60 ml/min/1.73m2)[18-20]. The CG estimate was accurate at GFR of 60 to 120 ml/min/1.73m2 than MDRD formula estimate [21]which are at par to our findings. The CG formula is useful to estimate the GFR in normal or mild renal disease patients only. The extent of disease in patients with moderate and severe kidney disease is ideally estimated by MDRD equation. But both formulae are not reliable to estimate the GFR especially with end stage kidney disease. This study suggests exploring better formula to precisely determine the GFR in chronic kidney disease patients.

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