Al-Nahrain College of Medicine

The Relationship Between Serum Creatinine And Estimated Glomerular Filtration Rate

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Abstract:

- **Background :** The serum creatinine concentration is widely interpreted as a measure of the glomerular filtration rate (GFR) and is used as an index of renal function in clinical practice. Glomerular filtration of creatinine, however, is only one of the variables that determines its concentration in serum. Aim of the study is to know the basis of relationship between serum Creatinine and estimated glomerular filtration rate.

- **Patients and method:** The study was conducted in Baghdad – Iraq, IMAM AL-KHADMIAN medical city. Patients with chronic kidney disease were chosen randomly. Data was collected under the following headings: age, sex, Weight, chronic kidney disease, haemodialysis, urea, and creatinine level and eGFR from 60 case notes.

- **Results:** we found that patients with stage 1 chronic kidney disease (8.33% their serum creatinine below 1.2 mg/dl, 3.33% with serum creatinine from 1.3 to 2.3 mg/dl). Stage 2 chronic kidney disease(8.33% below 1.2 mg/dl, 13.33% from 1.3 to 2.3 mg/dl). Stage 3a (1.66% below 1.2 mg/dl, 5% from 1.3 to 2.3 mg/dl) and stage 3b (8.33% from 1.3 to 2.3 mg/dl, 1.66% from 2.4 to 3.4 mg/dl). Stage 4 (5% from 1.3 to 2.3 mg/dl, 10% from 2.4 to 3.4 mg/dl, 3.33% from 3.5 to 4.5 mg/dl **).** Stage 5 (31.66% above 4.6 mg/dl).

- **Conclusion:** serum creatinine can be reliable as an index of kidney function in advanced stage of chronic kidney disease.

Introduction

The serum creatinine concentration is widely interpreted as a measure of the glomerular filtration rate (GFR) and is used as an index of renal function in clinical practice. Glomerular filtration of creatinine, however, is only one of the variables that determines its concentration in serum

- Glomerular Filtration Rate

Each human kidney contains 106 capillary units called glomeruli (1).The glomeruli produce an ultrafiltration of plasma as a result of pressure-driven filtration across the semipermeable glomerular capillary basement membrane. For the GFR of a single nephron (SNGFR), this relationship

$$\mathbf{SNGFR} = K_f \times P_{UF} = K_f \times (\Delta P - \Delta \pi) \qquad (1)$$

is quantitatively expressed by the following equation:

where Kf= ultra filtration coefficient (the product of surface area and hydraulic permeability); Puf = net ultrafiltration pressure, derived from the difference between the mean trans capillary hydrostatic and oncotic pressures.

$(\Delta P - \Delta \pi)$

Deviation of the GFR from normal values for age may result from various influences, including diet, postural changes, alterations in renal nervous tone, hormones, prostaglandins, atrial natriuretic peptide, drugs, pregnancy, and renal diseases. Because of such influences, the GFR is best determined under standardized conditions, which include discontinuation of medication, prior fasting, supine posture, sufficient water loading to maintain a urine flow rate >1 mL/min, and complete bladder emptying.

- Serum Creatinine and GFR

Numerous studies have examined the relationship of serum creatinine and endogenous creatinine clearance to the GFR. Implicit in the utilization of serum creatinine as a marker of the GFR is the assumption that the following two criteria are satisfied: first, that creatinine is a perfect filtration marker; and second, that creatinine metabolism is constant among individuals and over time, with the creatinine production rate being equal to the renal excretion rate. In the theoretical situation where both criteria are satisfied, the serum creatinine is inversely proportional to the GFR, so that each halving of the GFR results in a doubling of the serum creatinine concentration (2).

- Creatinine as a Filtration Marker

Glomerular filtration of creatinine. Creatinine fulfils most, but not all, of the requirements for a perfect infiltration marker. It is not protein bound; it is freely filtered; it is not metabolized by the kidney; and it is physiologically inert. Although concentrations of creatinine are increased in uraemia, creatinine per se is nontoxic. A substantial fraction of creatinine excretion by the kidney is, however, a result of proximal tubular secretion, such that in normal individuals creatinine clearance regularly exceeds inulin clearance by 10- 40% ; thus, the ratio of creatinine clearance to inulin clearance ranges from 1.1 to 1.4 (3-7). this contribution to creatinine excretion and the resulting overestimation of GFR have largely been ignored.

knowledge of the precise value for the GFR has previously had little impact on clinical decision making.

Several reports indicate that in patients with low rates of urine flow, e.g., in decompensated heart disease or uncontrolled diabetes, the ratio of clearances of creatinine and inulin is <1.0, raising the possibility of tubular reabsorption of creatinine (8-12).

In summary, creatinine is an imperfect marker of glomerular filtration because it is regularly secreted and at times reabsorbed by the renal tubules. Hence, creatinine clearance provides only a rough guide to the GFR.

- Chronic kidney disease:

Chronic kidney disease (CKD) refers to an irreversible deterioration in renal function that usually develops over a period of years (see Box 15.3, p. 388). Initially, it manifests only as a biochemical abnormality but, eventually, loss of the excretory, metabolic and endocrine functions of the kidney leads to the clinical symptoms and signs of renal failure, collectively referred to as uraemia. When death is likely without RRT (CKD stage 5), it is called end-stage renal disease (ESRD) (13).

i 15.3 Stages of chronic kidney disease (CKD)

Stage[1]	Definition[2]	Description	Prevalence[4]	Clinical presentation[5]
1	Kidney damage[3] with normal or high GFR (>90)	Normal function	3.5%	Asymptomatic
2	Kidney damage and GFR 60–89	Mild CKD	3.9%	Asymptomatic
3A	GFR 45–59	Mild to moderate CKD	7.6% (3A and 3B combined)	Usually asymptomatic
3B	GFR 30–44	Moderate to severe CKD		Anaemia in some patients at 3B Most are non-progressive or progress very slowly
4	GFR 15–29	Severe CKD	0.4%	First symptoms often at GFR <20 Electrolyte problems likely as GFR falls
5	GFR <15 or on dialysis	Kidney failure	0.1%	Significant symptoms and complications usually present Dialysis initiation varies but usually at GFR <10

[1]Stages of CKD 1–5 were originally defined by the US National Kidney Foundation Kidney Disease Quality Outcomes Initiative 2002. In the 2013 Kidney Disease Outcomes Quality Initiative (K/DOQI) CKD guideline update, the suffices A1, A2 and A3 are recommended, indicating the presence of albuminuria of <30, 30–300 and >300 mg/24 hrs respectively, in view of the prognostic importance of albuminuria. [2]Two GFR values 3 months apart are required to assign a stage. All GFR values are in mL/min/1.73 m^2. [3]Kidney damage means pathological abnormalities or markers of damage, including abnormalities in urine tests or imaging studies. [4]From Hill NR, Fatoba ST, Oke JL et al. Global prevalence of chronic kidney disease – a systematic review and meta-analysis. PLoS One 2016; 11:e0158765. [5]For further information, see page 415.

Aim of the study:

is to know the basis of relationship between serum Creatinine and estimated glomerular filtration rate

Patients and Methods

- Patients

The study was conducted in Baghdad – Iraq , IMAM AL-KHADMIAN medical city. Patients with chronic kidney disease were chosen randomly.

Data was collected under the following headings: age, sex, Weight, chronic kidney disease, haemodialysis, urea, and creatinine level, from 60 case notes.

in the month of march 2019. They were divided into two groups: group 1 (CKD without haemodialysis) and group 2 (CKD with haemodialysis). These total 60 Iraqis patients comprised of 34 males and 26 females

(male-female ratio of nearly 1:1). There ages were ranging from 18 to 80 years old.

- Methods

Creatinine:

Serum creatinine was measured by a liquicolor Kit (Human), using the compensated kinetic Jaffe assay. It's a photometric colorimetric test for endpoint measurement of creatinine, method with deproteinisation.

Estimated Glomerular Filtration Rate (GFR):

The glomerular filtration rate (GFR) is an estimate of the filtering capacity of the kidneys. It is usually expressed as millilitres (mL) per minute (min) and adjusted to a "standard" body size with a surface area of 1.73 meters2. The normal GFR ranges between 95 -120 mL/min/1.73m2 but it varies depending on age, gender and body size. There are many formulae for estimating GFR (14,15) we calculated the eGFR in the present study by using the formulae derived from the Modification of Diet in Renal Disease (MDRD) study (16). The Cockcroft and Gault estimate requires a weight, information is not routinely available in the biochemistry laboratory.

MDRD formula:

GFR (mL/min/1.73 m2) = 175 x [serum creatinine (SI) x 0.011312]-1.154 x [age}-

0.203 [e x [1.212 if black] or x [0.742 if female]

Results were considered statically significant if P-value is less than 0.05.

Results

Table (1): Sex distribution in the 2 study groups

	CKD Patients Without Dialysis No. (%)	CKD Patients With Dialysis No. (%)	P value
Females	20 (50%)	6 (30%)	0.242
Males	20 (50%)	14 (70%)	

Table (2): Age distribution in the 2 study groups

	CKD Patients Without Dialysis mean±SD	CKD Patients With Dialysis mean±SD	P value
Age (yr)	44.4±14.67	51.6±19.46	0.155

Table (3): Creatinine distribution in the 2 study groups

	CKD Patients Without Dialysis mean±SD	CKD Patients With Dialysis mean±SD	P value
Creatinine (mg/dl)	1.72±3.05	10.26±4.77	<0.000

Table(4) : eGFR distribution in the 2 study groups

	CKD Patients Without Dialysis mean±SD	CKD Patients With Dialysis mean±SD	P value
eGFR (ml/min/ 1.73m2)	60.51±31.34	6.43±3.17	<0.000

Table(5) : Creatinine level distribution among CKD patients

Creatinine (mg/dl)	Chronic Kidney Disease (%)(n)					
	Stage (1)	Stage (2)	Stage (3a)	Stage (3b)	Stage (4)	Stage (5)
< 1.2	8.33% (5)	8.33% (5)	1.66% (1)			
1.3 – 2.3	3.33% (2)	13.33% (8)	5% (3)	8.33% (5)	5% (3)	
2.4 – 3.4				1.66% (1)	10% (6)	
3.5 – 4.5					3.33% (2)	
> 4.6						31.66% (19)

In the present study on the relationship between serum creatinine and estamiated GFR, as we said before, we divided our patients into two groups : group 1 (CKD patients without haemodialysis), group 2 (CKD patients with haemodialysis).

The results of the presen study were that sex distribution in the study were 34 males (56%) and 26 females (44%) almost nearly 1:1 male to female. Males patients among group 1 were 20 male (50%) and females patients among group 1 were 20 females (50%). While in group 2, males

patients were 14 males (70%) and females were 6 females (30%). We measured P value and we found there was no significance in the sex distribution between male and female.

For the age distribution also there was no significance in the age between the two groups, as the mean age for group 1 was 44.4 and standard deviation 14.67. The mean age for group 2 was 51.6 and standard deviation 19.46.

But there was marked significance in the P value for serum creatinine between the two groups, the mean for group 1 was 1.72 mg/dl and standard deviation was 3.05 and for group 2 the mean was 10.26 mg/dl and standard deviation was.

The P value for estimated GFR was also significance between the two groups , the mean for group 1 were 60.51 ml/min/1.73 m2 and standard deviation was 31.34. group 2 , the mean was 6.43 ml/min/1.73 m2 and standard deviation 3.17.

We categorized our 60 patients according to their stage of chronic kidney disease and serum creatinine level. : we found that patients with stage 1 chronic kidney disease (8.33% their serum creatinine below 1.2 mg/dl, 3.33% with serum creatinine from 1.3 to 2.3 mg/dl). Stage 2 chronic kidney disease(8.33% below 1.2 mg/dl, 13.33% from 1.3 to 2.3 mg/dl). Stage 3a (1.66% below 1.2 mg/dl, 5% from 1.3 to 2.3 mg/dl) and stage 3b (8.33% from 1.3 to 2.3 mg/dl, 1.66% from 2.4 to 3.4 mg/dl). Stage 4 (5% from 1.3 to 2.3 mg/dl, 10% from 2.4 to 3.4 mg/dl, 3.33% from 3.5 to 4.5 mg/dl). Stage 5 (31.66% above 4.6 mg/dl).

Discussion

This study investigated the performance of relationship creatinine-based eGFR formula in chronic kidney disease patients in Al-Khadmia teaching hospital. An accurate eGFR measurement is extremely important as a tool for CKD diagnosis. The eGFR was measured and calculated by MDRD formula. Filtration of creatinine is reduced as a consequence of diminished GFR in chronic renal disease. In our study the increased in serum creatinine was so obvious as the patients kidney health was becoming worse and by that we mean advancing chronic kidney disease so this reflects that serum creatinine was inversely proportionate to estimated GFR in which we based our study on. Our study was discussed before in an article which we agreed with. That study discussed serum creatinine as an index or marker for the assement of the kidney health. Which state that the rate of rising in serum creatinine reflected the rate of decline in GFR and thus could be used as a measure of the rate of progression of renal disease to predict the time when initiation of dialysis would be required and to determine the efficacy of treatments to halt progression of renal failure (17).

Conclusion

serum creatinine can be reliable as an index of kidney function in advanced stage of chronic kidney disease.

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