Frequency of Renal Insufficiency by Estimation of GFR in Patients with Normal Serum Creatinine Level Undergoing Coronary Angiography

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Abstract-
Objective/Aim: The aim of this research is to find out how often renal insufficiency occurs in patients who have a normal level of serum creatinine and are undergoing coronary angiography, through the estimation of their glomerular filtration rate (GFR).
Background: The prevalence of cardiovascular disease is high and continues to grow worldwide, leading to a significant number of patients needing cardiac catheterization. These procedures may result in various pre and post procedural complications; contrast induced nephropathy (CIN) is one of them and is associated with prolonged hospitalization and adverse clinical outcomes.
Materials and Methods: This Cross sectional study was conducted in the Cardiology and Cardiac Catheterization departments of Punjab Institute of Cardiology, Lahore. For Six months from June 2012 to November 2012. Four hundred and fifty patients fulfilling the inclusion were selected for this study. The effect modifiers (Diabetes mellitus and Hypertension) were addressed by stratification. Glomerular filtration rate (GFR) was calculated for each patient using the Cockcroft-Gault (C-G) equation and a Glomerular Filtration Rate <80 ml/min was labeled as renal insufficiency.
Results: The mean age of the patients was 52.6±9.4 years. The mean serum creatinine of the patients was 0.9±0.2 mg/dl. The mean GFR of the patients was 102.9±31.0 ml/min. There were 107 (23.8%) patients in the GFR range of <80 ml/min and 343 (76.2%) patients of GFR range of >80 ml/min. There were 107 (23.8%) patients had renal insufficiency and 343 (76.2%) patients had not found renal insufficiency.
Conclusion: The study has determined that certain patients who have normal levels of serum creatinine may have an abnormal GFR. Although serum creatinine is a crucial screening test for individuals with renal impairment, their renal function could still be impaired while their serum creatinine levels remain within the normal range.
Keywords: Renal insufficiency, GFR, serum creatinine, coronary angiography

I. INTRODUCTION

The world is facing a significant and continuously rising load of cardiovascular disease (CVD), leading to a considerable population of patients necessitating cardiac catheterization and percutaneous coronary intervention (PCI).[1] These methods could lead to different complications before and after the procedure, and contrast induced nephropathy (CIN) is among them. This condition is linked to extended hospital stay and unfavorable clinical consequences.[2,3,4]

The occurrence of atherosclerotic cardiovascular disease (CVD) is strongly linked to concurrent ailments such as diabetes mellitus (DM) and hypertension (HTN), which can negatively impact kidney function and result in a high number of patients with impaired renal function.[5,6]

While the occurrence of CIN is not common among patients with healthy kidneys, those with pre-existing renal impairment may experience significantly higher rates of the condition.[7,8]

Due to the growing prevalence of imaging methods that rely on contrast media, particularly in older individuals and with rising procedural intricacy, interventional cardiologists continue to regard CIN as a significant issue.[9] Sufficient preventative actions such as saline infusion, water pills, mannitol, N-acetylcysteine, calcium channel blockers, theophylline, endothelin receptor blockers, and dopamine are essential in diminishing the increased sickness and fatality linked with CIN in patients at a higher risk.[7]

Research has demonstrated that having insufficient kidney function at the start of treatment is the primary danger factor for CIN.[10] While numerous doctors employ serum creatinine (S.Cr) as a technique for screening for kidney damage, S.Cr levels may be within the usual range even when kidney function is severely hindered. This could result in a considerable number of patients with underlying kidney insufficiency and who may eventually develop CIN being missed.

On the contrary, the Glomerular filtration rate (GFR) has conventionally been regarded as the most comprehensive indicator of kidney function in both wellness and illness. Utilizing equations like the Cockcroft-Gault formula $\{(140\text{-age}) \times (\text{Wt in Kg}) \times (0.85 \text{ if female}) / (72 \times Cr)\}$ to estimate GFR from serum creatinine can yield a more precise estimation of renal function.[11] It has been observed that up to 34.1% of patients with serum creatinine levels within the normal range may have significantly anomalous

calculated GFR with C-G values < 80ml/min.[12] Furthermore, it has been reported that roughly 29.9% of the adult populace residing in urban regions of Pakistan experience a decreased GFR.12 A different research indicates that 15.2% of individuals possess a reduced GFR despite having standard serum creatinine levels.[13]

Due to the fact that GFR declines as individuals age, even if their serum creatinine levels are within the normal range, it may be beneficial to use a straightforward GFR estimating equation, such as the C-G equation, to screen patients who are receiving coronary angiography and detect any underlying renal insufficiency.

The rationale of this study is that literatures showed variability of the data and it requires further confirmation. So I want to reassess it. Since most of them have to proceed for angioplasty if required, so magnitude of renal insufficiency, if significantly high, may lead to change in the protocol of pre-procedure screening in the form of estimation of GFR and appropriate preventive measures like saline hydration, N-acetyl cysteine.

II. MATERIAL AND METHODS

This Cross sectional study was conducted in the Cardiology and Cardiac Catheterization departments of Punjab Institute of Cardiology, Lahore. For Six months from June 2012 to November 2012. The determined size of the sample is 450 instances, considering a 4.5% degree of precision and a 95% level of certainty, while also accounting for the anticipated proportion of renal inadequacy. i.e. 34.1% of patients having normal serum creatinine levels undergoing coronary angiography.

Inclusion Criteria

1. Patients undergoing coronary angiography having normal serum creatinine (<1.5mg/dl).
2. Both genders.
3. Age 30-75 years.

Exclusion Criteria

1. Patients have history of chronic renal failure or who are on renal replacement therapy.
2. Patients have history of dye allergy.
3. Patients undergoing primary PCI on clinical and ECG evidence of acute myocardial infarction.

Four hundred and fifty patients fulfilling the inclusion and exclusion criteria were selected from Cardiology and Cardiac Catheterization departments of Punjab Institute of Cardiology, Lahore. A verbal informed consent was taken from all patients to include their data in the study. Clinical history was taken and physical examination was done. Demographics like age, sex, and addresses were noted. Laboratory investigations like serum Urea and creatinine levels were carried out in Punjab Institute of Cardiology laboratory and the effect modifiers (Diabetes mellitus and Hypertension) were addressed by stratification. Glomerular filtration rate (GFR) was calculated for each patient using the Cockcroft-Gault (C-G) equation and a Glomerular Filtration Rate <80 ml/min was labeled as renal insufficiency. All the data was entered in the proforma (attached).

Statistical Analysis

The information was inputted and examined using SPSS 11 edition intended for Windows. All categorical variables like sex and renal insufficiency were expressed as frequency and percentages and numerical variables like age, Serum creatinine levels and GFR were expressed as mean and standard deviation. Since it is a cross sectional survey, so no test of significance was applied.

III. RESULTS

The average age of the individuals was 52.6±9.4 years. Among them, 49 (10.9%) individuals belonged to the age range of 30-40 years, 148 (32.9%) belonged to the age range of 41-50 years, 175 (38.9%) individuals belonged to the age bracket of 51-60 years, 61 (13.5%) individuals belonged to the age range of 61-70 years and 17 (3.8%) individuals belonged to the age range of 71-75 years.

Regarding the categorization of patients by gender, there were 352 (75.2%) male individuals and 98 (21.8%) female individuals. The average weight of the patients was 76.5±13.0 kg. There were 2 (0.5%) patients weighing up to 50 kg, 40 (8.9%) patients with weights between 51-60 kg, 118 (26.2%) patients weighing between 61-70 kg, 149 (33.1%) patients weighing between 71-80 kg, 94 (20.9%) patients weighing between 81-90 kg, 33 (7.3%) patients weighing between 91-100 kg, 4 (0.9%) patients with weights between 101-110 kg and 10 (2.2%) patients weighing between 111-120 kg.

The mean serum creatinine of the patients was 0.9±0.2 mg/dl. There were 360 (80.0%) patients in the serum creatinine range of upto 1.0 mg/dl, 69 (15.3%) patients in the serum creatinine range of 1.1-1.2 mg/dl and 21 (4.7%) patients in the serum creatinine range of 1.3-1.4 mg/dl.

The mean GFR of the patients was 102.9±31.0 ml/min. There were 107 (23.8%) patients in the GFR range of <80 ml/min and 343 (76.2%) patients of GFR range of >80 ml/min.

In the distribution of patients by risk factors, diabetes mellitus was found in 29 (6.4%) patients, hypertension in 101 (22.4%) patients, hypertension + diabetes mellitus in 62 (13.8%) patients, smoking in 70 (15.6%) patients and no risk factor was found in 188 (41.8%) patients (Table 1).

In the distribution of patients by renal insufficiency, 107 (23.8%) patients had found renal insufficiency and 343 (76.2%) patients had not found renal insufficiency (Table 2).

In the stratification of risk factors with renal insufficiency, out of 29 patients of diabetes mellitus renal insufficiency was found in 7 patients, in 101 patients of hypertension, renal insufficiency was found in 22 patients, in 62 patients of hypertension and diabetes mellitus, renal insufficiency was found in 20 patients, in 70 patients of smoking, renal insufficiency was found in 14 patients, in 188 patients of no risk factor, renal insufficiency was found in 44 patients (Table 3).

Table 1: Distribution of patients by age, gender, weight (kg), serum creatinine (mg/dl), GFR (ml/min) and Risk factors (n=450)

Age (Years)	No. of patients	Percentage
30-40	49	10.9%
41-50	148	32.9%
51-60	175	38.9%
61-70	61	13.5%
71-75	17	3.8%

Mean±SD	52.6±9.4	
Gender		
Male	352	78.2%
Female	98	21.8%
Weight (kg)		
Upto 50	2	0.5%
51-60	40	8.9%
61-70	118	26.2%
71-80	149	33.1%
81-90	94	20.9%
91-100	33	7.3%
101-110	4	0.9%
111-120	10	2.2%
Mean±SD	76.5±13.0	
Serum creatinine (mg/dl)		
Upto 1.0	360	80.0%
1.1-1.2	69	15.3%
1.3-1.4	21	4.7%
Mean±SD	0.9±0.2	
GFR (ml/min)		
<80	107	23.8%
≥80	343	76.2%
Mean±SD	102.9±31.0	
Risk factors		
Diabetes mellitus	29	6.4%
Hypertension	101	22.4%
Hypertension + diabetes mellitus	62	13.8%
Smoking	70	15.6%
No risk factor	188	41.8%

Table 2: Distribution of patients by renal insufficiency (n=450)

Renal insufficiency	No. of patients	Percentage
Yes	107	23.8%
No	343	76.2%

Table 3: Stratification of risk factors with renal insufficiency (n=450)

Risk factors	Renal insufficiency	
	Yes	No
Diabetes mellitus	7	22
Hypertension	22	79
Hypertension + diabetes mellitus	20	42
Smoking	14	56
No risk factor	44	144
Total	107	343

IV. DISCUSSION

Evaluation of kidney function is commonly performed by measuring serum creatinine (SCr) due to its ease and affordability. Nonetheless, SCr does not provide precise data about glomerular filtration rate (GFR). According to two distinct investigations, a significant proportion of patients, varying from 13.9-29.9%, have exhibited reduced GFR levels despite having normal levels of serum creatinine.[14,15] If only serum creatinine (SCr) is relied upon as an indicator of renal function, there is a high probability of failing to identify a considerable proportion of patients with underlying renal insufficiency, who could then go on to develop contract-induced nephropathy (CIN). To calculate GFR, a variety of equations have been created that estimate GFR from SCr while taking into account the patient's age, gender, and body weight. The C-G and MDRD (Modification of Diet in Renal Disease) equations are the most popular and provide a fairly accurate approximation of GFR.[16] The use of creatinine-based formulae is a beneficial approach to detect patients with underlying kidney dysfunction and prevent the occurrence of CIN. This method is both economical and simple to administer.

The C-G equation has demonstrated a strong association with GFR measured by [99mTc]-DTPA in the GFR range of 14-100ml/min, with a correlation coefficient of 1.01, r=0.92.[17] The NKF guidelines specify that renal injury is indicated by a GFR of 60-89ml/min.[18] To classify a patient as having renal insufficiency, a <80ml/min threshold was applied in this study, as GFR typically declines with age, as seen in the Baltimore Longitudinal Study.[19] Another investigation found that a person with a GFR of 120ml/min at the age of 30 can still have a GFR of >80ml/min at the age of 80 and be considered healthy.[20]

On the other hand, the Glomerular filtration rate (GFR) has been historically viewed as the most comprehensive indicator of kidney function in both wellness and illness. Utilizing equations like the Cockcroft-Gault formula $\{(140-age) \times (weight\ in\ Kg) \times (0.85\ for\ females) / (72 \times Cr)\}$ to estimate GFR from serum creatinine provides a more precise approximation of renal function.[11] Approximately 34.1% of patients who exhibit normal levels of serum creatinine may possess significantly abnormal calculated GFR, which can be less than 80ml/min according to C-G values. Based on the study conducted by Mujtaba et al, it has been determined that almost 29.9% of the adult urban population in Pakistan experiences a decline in GFR.[12] Duncan et al showed 15.2% of population has decreased GFR in spite normal serum creatinine.[13]

As individuals age, their GFR tends to decrease, even if their serum creatinine levels are normal. To detect potential renal insufficiency, it may be helpful to use a basic GFR estimating equation, such as the C-G equation, to screen patients who are undergoing coronary angiography.

Our research revealed that the patients had an average age of 52.6±9.4 years. This age range is similar to that found in Mujtaba et al's study,[12] where the average age was 52.8±10.2 years.

Similarly, Duncan et al.,[13] found that the patients' average age was 57.0±18.0 years, which is also comparable to our study.

In our research, the male patients accounted for 75.2% while female patients accounted for 21.8%. When contrasted with Mujtaba et al's[12] investigation, their study revealed 77.6% male patients and 22.4% female patients, which is akin to our findings. In our research, the average weight of the subjects was 76.5±13.0 kg. This is similar to Mujtaba et al's study where the mean weight was 67.6±12.3 kg, indicating comparable results between our study and theirs.[12]

In our investigation, the average serum creatinine level among the patients was 0.9±0.2 mg/dl. Our findings indicated that the mean serum creatinine level of the patients was similar and on par with the study conducted by Mujtaba et al.,[12] where it was also recorded as 0.9±0.2 mg/dl.

In our research, the average glomerular filtration rate (GFR) among the subjects was 102.9±31.0 ml/min. This is similar to Mujtaba et al.'s investigation where the mean GFR of the patients was 95.1±28.3 ml/min, indicating comparability between their findings and ours.[12]

In our research, renal insufficiency (GFR <80 ml/min) was observed in 23.8% of patients. Our findings are similar to Mujtaba et al.'s study, which reported a prevalence of 34.1% of patients with renal insufficiency.[12]

A different investigation carried out by Duncan et al.,[13] discovered that 15.2% of patients had kidney dysfunction, which is similar to the results of our own study.

A research was carried out by Jafar et al in 2005 in Pakistan, where they approximated the incidence of decreased GFR in people aged 40 and over to be 29.9%, which is similar to the outcomes of our study.[15]

Based on the preceding discourse, it has been determined that certain patients exhibit anomalous GFR despite having typical serum creatinine levels. Consequently, GFR evaluations for detecting renal inadequacy ought not to be impacted by serum creatinine levels within the typical range.

V. CONCLUSION

The findings of this investigation indicate that a portion of patients who exhibit a regular level of serum creatinine possess an anomalous GFR. Despite renal impairment, serum creatinine is commonly employed as a significant screening exam. Consequently, even when serum creatinine is within the normal range, GFR ought to be regarded as an approximation of renal deficiency.

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